KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
SIMPLY WORDED—EXACTLY DESCRIBED

LONDON: JANUARY 1, 1895.

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SERPENT-FEEDING.

By Dr. ARTHUR STRADLING, C.M.Z.S.

SNAKES in captivity under proper conditions are a fairly healthy, though by no means a long-lived, race. The largest specimen at the Zoological Gardens is the oldest inhabitant amongst the Ophidia in the Reptile House, the great reticulated python, measuring about twenty-six feet in length, presented by Dr. Hampshire in 1876—the oldest snake and, indeed, the oldest reptile, as far as residence in the menagerie goes, but not absolutely the most venerable denizen of the Reptilium, a distinction enjoyed at the present time by a blind example of *Amphiuma means*, which arrived there more than a quarter of a century ago. In my own vivarium, serpents have survived for twenty-one years after capture or birth in my cages; of the former, one at least had reached full maturity in the wild state. Of their normal duration of life under natural conditions we, of course, know nothing—no more than we do of any other animal. The struggle for existence must be a very severe one in their case, owing to their comparatively defenceless organization, and the fact that they are exceedingly popular as an article of diet with a vast number of creatures, circumstances which must conduce speedily to the extermination of any species within any given area, were it not for their abundant fecundity. Broods of young ones vary from thirty to a hundred in number.

Kept in confinement, they develop very few diseases liable to be attended with fatal results. They catch common colds, manifested by nasal catarrh and congestion, more or less inflammatory, of the air passages; they are somewhat prone to flatulent dyspepsia, and at times suffer from something closely akin to muscular rheumatism, but from these ailments they usually recover. A certain localized effusion of blood, nearly allied to *purpura* in the human subject, is an affection of more serious import; and cysts filled with cheesy matter, or fibrous tumours especially apt to undergo calcareous degeneration, may kill, but the presence of either, of enormous growth, is perfectly compatible with prolonged existence, provided that it does not press on any nerve or organ, the function of which is essential to life. A coral snake in my own collection just now has had a constant succession of small tumours, extending in a chain along the "keel" of its back throughout its whole length; they are freely movable on the subjacent parts, and are in no way connected with the spine, and I have therefore removed them as fast as they appeared, the creature remaining in perfect health. I may mention here, as a pathological curiosity, that I once found an imperfect skeleton of a serpent in an ants' nest in Nicaragua, associated with which was a large mass of calcareous material, presenting unmistakable evidence of being a morbid growth which had undergone that peculiar form of degeneration; and it furthermore proved that the reptile so affected was a female. The most characteristic and deadly complaint from which caged snakes suffer is that known as "canker"—a disease which manifests itself by a thick, white, membranous efflorescence about the interior of the mouth and fauces, and which very closely simulates diphtheria in its symptoms and progress, even to the circumstance that its gravity depends in one class of cases mainly on the nature of the local development, while in another the constitutional and general effects are of far more importance. Canker appears to originate from cold, and is, I believe, unknown in the tropics; in certain stages it is contagious, and in all it is almost inevitably fatal. An attempt was made not long ago to establish the identity of this malady with tubercle, and its prevalence in menageries was ascribed to the practice of feeding the serpents with birds infected with avian consumption! The possibility of cultivating the tubercle bacillus within the body of a snake seemed at first to lend some slight plausibility to this wild hypothesis, but it was pointed out that, in a creature whose life-processes are so sluggishly performed, and so tolerant of adverse environment, cultivations of bacilli may be effected in precisely the same way as in a laboratory test-tube—that is to say, without any real vital invasion.

Whence, then, comes the great mortality amongst captive ophidians, since they enjoy what is a veritable immunity from disease, compared to the hygienic record of importations from the forests and jungles in other walks of animal life? It is safe to assert that not one in fifty of all the specimens caught survive—even of those which have sustained no injury in becoming prisoners, and which reach comfortable quarters in Zoological Gardens or the vivaria of amateurs. And this difficulty of maintenance arises from the singular and inexplicable fact that the vast majority of them never feed after capture, but undergo voluntary starvation in the presence of an abundance of suitable food.

Capricious and absurdly selective as snakes are in the matter of diet, it would seem at first as if all of them must run the risk of perishing from starvation even in a state of nature, when we consider their numerous and apparently overwhelming disabilities. Destitute of hands, feet, fingers

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and claws—with no faculty of scent for the tracking of prey, nor rapidity for pursuit—and withal one of the most shortsighted animals on the face of the earth (I consider that no snake can see anything distinctly at a distance equal to twice its own length), it must depend, one would think, for its sustenance on such creatures as happen to run literally against its nose. Yet it is remarkably fastidious in its choice of food, every species being practically limited to one or two articles of diet, in defect of which they will absolutely starve to death, though enjoying abundant opportunities of partaking of other things just as conducive to nutrition. Individual specimens, too, belonging to the same species, exhibit marked prejudices and predilections with regard to what they eat and drink. Among my own snakes I find that one will accept guinea-pigs and nothing else, while its brother may betray quite as keen and exclusive a preference for rats or rabbits. All certainly have one great advantage which helps them to maintain this rigid attitude of selection, and that is the phenomenal length of time during which they can fast compatibly with the preservation of health, as well as the relatively small amount of food necessary to them to support their lowly-vitalized existence and even to provide for growth. Our common grass-snake, which attains a length of four feet or more, probably does fairly well if it gets six good frogs a year. Here, at any rate, is a fine and vigorous example of its near relation, the viperine snake of the South of Europe, which has contented itself with four medium-sized frogs per annum during the eight years that it has been in my possession, though it might have swallowed ten times that number had it chosen to avail itself of its privileges. Like most animals in captivity, serpents when they do consent to feed frequently grow to dimensions not exemplified amongst those remaining in their native haunts, owing to the excess and regularity of the supply of nourishment. All of them will take small animals rather than large, *cæteris paribus;* the python or anaconda capable of swallowing a deer will most likely be found to live on creatures about the size of rabbits, and will undoubtedly thrive better thereon. Hugely disproportionate meals, though not unknown, are probably rare amongst wild snakes, and indeed are not altogether devoid of danger, since the morsel will sometimes decompose in the stomach before the whole of it can be submitted to the action of the gastric juice, a state of affairs leading to vomiting, inflammation of the lining mucous membrane of the intestine, and perhaps death. A young python of my own managed to draw itself over a large rabbit intended for a bigger cagemate; it swelled almost to bursting with the gaseous products of decomposition, and at last (after eight days) rejected the meal in a horribly fœtid condition. It never fed again, and could not retain the lightest forms of peptonized aliment introduced into its stomach, not even the bodies of small animals killed by rattlesnakes. I believe the venom of a viperine serpent to be the most powerful solvent of albumen to be found in nature, flesh thoroughly impregnated with a full injection of the fluid being already on the high road to digestion. Not only snakes but other animals will retain and absorb food treated in this way when all else is regurgitated.

One need be in no hurry to resort to an artificial process of administering nourishment in order to avert death by starvation in the case of a snake. As a matter of fact, I always give mine three or four months, after arrival, to recover from the disturbance to the nervous system entailed by capture and transit, unless they should happen to be in a preternaturally feeble condition. It is hardly credible to those who have not lived in constant association with these reptiles that they may exist for two years or more without any food whatever, and yet enjoy perfect health and possibly feed well at the end of that time—this, too, be it remembered, in a temperature which ensures the maintenance of their bodily activity all the while, and not in a state of torpid hybernation. A fine boa constrictor of mine took a meal on or about Christmas Day, 1881. Throughout the whole of 1882 and 1883 it refused all food, though it continued well, shedding its skin at regular periods, and "curling up" in a normal manner (a restless snake, one that is always roaming about its cage, may be suspected of being ill, while a healthy one spends the greater part of its leisure quiescent, with its folds disposed one above the other). It began to eat again in January, 1884, and has fed freely ever since. Another member of the same species, one of the brood of thirty-one to which the Panama boa at the Zoological Gardens gave birth on the 30th of June, 1877, developed a huge cruciform tumour in the neck when it was six years old, the pressure of which interfered with its swallowing, though it did not prevent respiration; it did not die until it had undergone a period of twenty-two months' abstinence, and even then the proximate cause of its decease appeared to be the loss of nerve force. Similar instances might be culled from the records of most menageries where the Ophidia are kept in any numbers.

A serpent, under normal circumstances, sheds its skin at intervals of from three to six weeks, very young specimens more frequently, very old ones not so often. This function does not depend upon the question of feeding, though it may be modified thereby, and is also liable to be hastened or retarded by the character of the food. It is also independent of the phenomena of growth. For some days—possibly a week or two—before this shedding of the cuticle, the serpent never eats; but directly the epidermis is cast, it is ready and eager for prey. It usually happens, however, that an exception to this rule occurs once in the course of the year, when the creature remains from one shedding to the next, or perhaps passes over two, without taking a meal; and I have observed that this corresponds, roughly, with the time of its hybernation in its native habitat. The trait wears out in a few years, but if it should produce offspring soon after its reception into captivity, the young ones will exhibit the same peculiarity.

The reader will please understand that all my remarks in the course of this paper apply to serpents kept always, summer and winter, at full feeding heat, and never allowed to become torpid from cold. The act and fact of swallowing a meal may be taken as the criterion of the temperature at which they should live, since the process of swallowing food is absolutely the most severe exertion which snakes are called upon to perform throughout their whole existence, as those who have witnessed the spectacle will readily believe. Even the lightning flash, coil, and crush of the constrictors involves a less expenditure of force; a python will kill at a degree of warmth lower than that which is necessary to induce it to eat.

For several years I have resorted with singular success to a method of feeding the serpents in my collection by artificial means, under what are apparently very abnormal conditions, a success which is so marked, both as regards the welfare of the creatures which have always been objects of the highest and most affectionate interest to me, and my own convenience in keeping them, that I think seriously of dispensing with my larder of animated provisions altogether, and for the future bringing up every inmate of my Reptilium, "feeder" and "starver" alike, by hand. At such intervals as experience teaches me to consider suitable, I open their mouths and simply fill them up with pieces of raw meat, without taking into account what their

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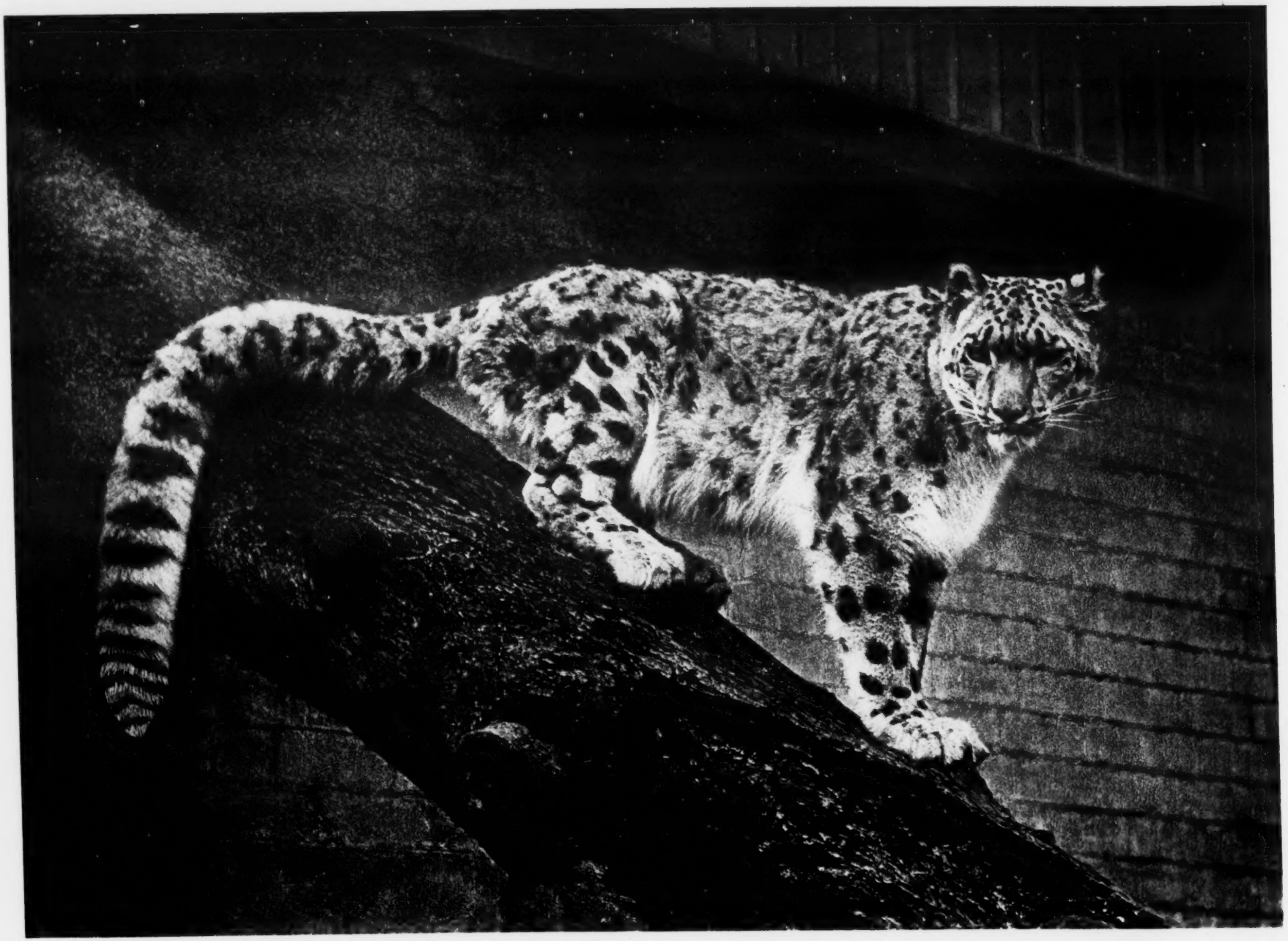

From a Photograph] THE OUNCE, OR SNOW LEOPARD. [*by Gambier Bolton.*

To illustrate rosette-like spots, with light centres; the spots on the limbs are, however, solid.

"natural" diet may be—ducks, frogs, rats, mice, pigeons, lizards, guinea-pigs, rabbits, other snakes, small birds, or what not. And I have proved to demonstration that they thrive better, keep more healthy, and become tamer, when submitted to this process, than do any which are willing to depend upon their own exertions for their subsistence. A moiety of the individuals of the same broods, as well as fresh arrivals selected at random from a group of the same size, weight, and condition, have been so treated by me to the number of some hundreds, and in almost every case have grown bigger than those which fed voluntarily, while, even setting aside starvation, my losses by death are almost *nil*. The other day I sent to the Zoological Society's Gardens a diamond snake of a size never seen there previously, reared in this way; and I am able to keep alive and in grand condition delicate species like some of the tree-boas, shy feeders such as the smooth snake and viper, and those whose food in ordinary—consisting of lizards or their own kind—would be well-nigh impossible to procure in sufficient quantity, like the coral snakes of tropical America. Furthermore, I have at the present moment a Trinidad boa which broke its jaw some years ago, and a West African python with a stricture of the œsophagus, the result of injury received in capture, both of which are fat and happy, though quite incapable of feeding themselves.

Pure flesh I soon found to be too stimulating for them, causing them to shed their skins too frequently; so, when I have them, I add some dead frogs or common mice. In default of these, a handful of feathers or cinders, or pieces of soft string wrapped round the lumps of meat, do just as well, supplying the place of the bones, fur, or feathers of a swallowed animal as a mechanical aid to the digestive function. Newly-hatched specimens, which I used to treat with raw beef tea, mixed for digestive reasons with arrow-root or curdled milk, I now cram with meat in precisely the same way. I should say here that every snake will drink of its own accord, so that it is not necessary to administer water artificially. A boa or python ten feet long gets three pounds of beef or horseflesh about once a month on an average, and other snakes more or less according to their size; though there can be no absolute rule with regard to this, not even in the case of the same individual. A minor advantage of this plan lies in the fact that there is little or no fæcal excrement, the meat being wholly susceptible of conversion and absorption. The cages, therefore, require cleaning much less often, while the pure solid uric acid, which is excreted in large quantities by the kidneys, is saleable for laboratory purposes to the manufacturing chemists at a price varying with the market from five to ten shillings per pound. Serpents appear to have very little power of assimilating fat—some kinds less than others; if this be given in any quantity, it is simply poured off by the intestine, mixed with bile.

Cramming, though infinitely more convenient than the maintenance of an unlimited number of live birds, beasts, and reptiles to serve as food, has its little difficulties. The subject of this delicate attention positively refuses any connivance therewith under all circumstances, even though it be starving to death, and manifests the most determined opposition throughout—and four or five yards of demonstrative disfavour is no mean factor of antagonism in any mundane concern. The first thing is to get a good grip of the neck, just behind the head, with a degree of firmness which will do no injury and yet prevent escape, a grip only to be acquired by habitude. (It is extraordinary how one gains a sort of tactile instinct in dealing with these creatures, a kind of muscular sense which tells one what they are going to do.) For small ones, a bag may be recommended to restrain the movements of the body; but with the larger constrictors, pythons, and anacondas there is nothing for it but a rough and tumble struggle on the floor, and the use of bare hands, the legs, and stockinged feet. With a silver spatula I open the jaws by firm but gentle pressure in front, always taking advantage of the position to examine the mouth for the earliest signs of "canker." The interior should be dry and white; at the outset of canker the mucous membrane is swollen and has the appearance of red velvet, bleeding on the slightest touch, and flecked here and there with white aphthous spots. Then my assistant thrusts a piece of meat between the triple rows of teeth, and with the hand at liberty I push it down fairly into the stomach, using for the purpose a flexible india-rubber rod, but relying chiefly on pressure above the lump on the gullet outside. Very often we are compelled to hold on with all our might for a considerable time to prevent its return; but we are generally successful, and I think I may say that we do not experience the disaster of regurgitation once in five hundred crammings now—we were not so lucky at first, but have learned a good deal since then. And it is my earnest conviction that if this process were adopted in Zoological Gardens and other menageries, it would not only prevent the dreadful waste of ophidian life which goes on at present, but would result in an enormous economy of time and money, and might, moreover, admit of the solution of sundry physiological problems of the deepest interest.

[*by Gambier Bolton.*

THE OUNCE, OR SNOW LEOPARD.

To illustrate rosette-like spots, with light centres; the spots on the limbs are, however, solid.

From a Photograph.]

SPOTS AND STRIPES IN MAMMALS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

THOSE of our readers who have considered the subject at all are probably aware that, in those animals whose fur is ornamented with dark or light markings, these markings generally take the form either of longitudinal or transverse bands, or of spots; the latter being frequently arranged in more or less distinctly defined longitudinal lines, but never in transverse bands. Moreover, these markings, especially in the case of stripes and bands, are generally most developed on the upper surface of the body, although spots may be equally present on both the upper and the lower surfaces of the body. Many mammals, again, whether they be spotted or whether they be striped, have their tails marked by dark rings on a light ground; but this feature is also present in others in which the colour of the body is of a uniform tint. It must not, however, be supposed that there is any sharply-defined distinction between spotted and striped mammals, many of the civets, as well as some of the cats, having markings intermediate between true spots and stripes. Spots, again, are somewhat variable in configuration, some animals, like the hunting-leopard, having solid circular dark spots, while in others, such as the leopard and jaguar, they assume the form of dark rings enclosing a light centre. In other cases, as in the giraffe, the spots are enlarged so as to form large and more or less quadrangular blotches.

A survey of a museum or a menagerie will likewise show that spots and stripes are by no means equally prevalent in all groups of mammals. In the apes, monkeys, marmosets, and lemurs, for instance, they never occur; and when these animals are diversely coloured, the coloration takes the form of patches symmetrically disposed on the two sides of the body, but otherwise not following any very clearly defined mode of arrangement. Then, again, in the hoofed mammals, or ungulates, many species are

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more or less uniformly coloured; although the zebras are notable instances of transversely striped animals, while the giraffe is an equally marked example of the blotched type of coloration. Among the even-toed (*Artiodactyle*) subdivision of this order it may be also noticed that while in the more specialized forms, such as wild cattle and sheep, the coloration is more or less uniform, many of the antelopes show white transverse stripes on a dark ground. Dark transverse stripes are, however, known only in the case of the little zebra-antelope (*Cephalophus doriæ*) of Western Africa, and the gnus; while, although a lateral dark flank-stripe is present in some antelopes, and in the gazelles, none of these animals have the whole body marked by longitudinal dark stripes. In the case of the deer, it may be observed that a few species, like the fallow deer and the Indian spotted deer, are marked with longitudinal rows of white spots at all ages; while if the former be examined, it will be found that in many instances the young are similarly marked, whereas the adults are uniformly coloured. A similar state of things occurs among wild pigs and also in the tapirs, from which we are naturally led to infer that in this group of mammals, at least, a spotted or striped type of coloration is the original or generalized condition, while a uniformly coloured coat is an acquired or specialized feature. And we shall find that this will hold good for other groups.

Turning to the carnivorous mammals, we shall find that in many families, more especially the cats, hyænas, and civets, stripes and spots are far more generally present than a uniform coloration; although some groups, such as the bears, form a marked exception to this rule, the majority of the species being uniformly coloured, while none are striped or spotted. In some species of the weasel family—notably the badgers—it may be also noticed that while the sides of the head are marked by longitudinal dark and light stripes, the remainder of the body is uniformly coloured. And it may be mentioned here that many animals, such as donkeys and dun-coloured horses, retain a longitudinal dark stripe down the back, frequently accompanied by dark transverse bars on the limbs, while a uniform coloration prevails elsewhere.

In the gnawing mammals, or rodents, although many species are uniformly coloured, stripes and spots are prevalent; and a survey of the collection of these animals in a good museum will show that, whether the pattern take the form of stripes or of spots, the arrangement is invariably longitudinal and never transverse; and it may be observed that when spots are present, these are invariably light-coloured on a darker ground. Although in many cases the longitudinal stripes occupy the whole or a considerable portion of the upper surface, in some of the squirrels they are reduced to a dark and light stripe, or even a single light stripe on each flank, this remarkable type of coloration recalling the "speculum" on the wing of a duck.

We might extend our survey to other orders of mammals, but sufficient has been said to indicate the variability of the prevalent type of coloration in different groups, and we may accordingly now proceed to give a list of some more or less well-known mammals arranged according to the plan of their markings.

1. *Mammals with dark longitudinal stripes.* — Striped mangooses (*Galidictis*) of Madagascar, in one of which the stripes are very narrow and close, while in the other they are broader and more widely separated; these animals belonging to the civet family. The three-striped palm-civet (*Arctogale*). The genet, the markings here tending to break up into spots. The three-striped opossum. The palm-squirrel, and chipmunks (*Tamias*).

In all the above the stripes are dark upon a greyish ground, but in the following they take the form of black and white stripes, the white area being generally the larger; and it may be noted that all belong to the weasel family. They include the skunks, the South African weasel (*Pœcilogale*), and the Cape polecat (*Ictionyx*); while similar markings obtain on the head of the badger.

2. *Mammals with dark spots.*—These may be divided into several sub-groups, according to the form of the spots. Those in which the spots are small, more or less nearly circular, and solid, include the hunting-leopard, the tiger-cat, the lynx, the spotted hyæna, the large-spotted civet (*Viverra megaspila*) the African linsang (*Poiana*), and the young of the puma. The blotched genet (*Genetta tigrina*) forms a transition to blotches. While some of the civets are more or less distinctly spotted, in others the coloration is intermediate between spots and longitudinal stripes.

As species in which the spots are enlarged to form more or less quadrangular blotches, we may cite the giraffe and those Oriental civets known as linsangs.

By a splitting-up of a simple spot into a more or less complete ring of smaller ones, we have the rosette-like type of ornamentation, as exemplified in the leopard, the snow-leopard, and the jaguar. In the two former the ring encloses a uniform light area; but in the latter the central area generally carries one or more dark spots. A further development of the ring leads to the so-called clouded type, as displayed by the Oriental clouded leopard, the marbled cat, and the American ocelot. Here the ring becomes enlarged into a large squarish or oblong area, enclosing an area of

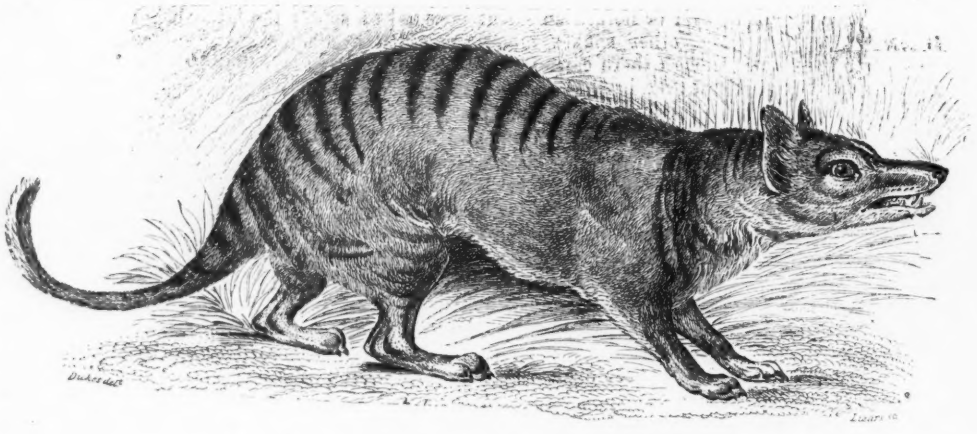


FIG. 1.—The Australian Thylacine. (From Waterhouse.)

darker hue than the general ground-colour of the fur, and bordered by a narrow black line; the black line in the two former species being, however, confined to the hinder half of the cloudings.

3. *Mammals with dark transverse stripes.*—Tiger, young lions, wild cat, striped hyæna, aard-wolf (*Proteles*), banded civet (*Hemigale*), banded mangoose (*Crossarchus*), zebra-antelope, gnus, zebras, thylacine (Fig. 1), and the water-opossum (*Chironectes*). Among these, it may be noted that in the zebras the stripes on the hind-quarters have a more or less marked longitudinal direction; and whereas in the true zebra and Grevy's zebra they consist of simple dark bands on a light ground, in Burchell's zebra the light areas between the dark stripes are traversed by an intermediate stripe of somewhat darker hue than the ground-colour.

4. *Mammals with white spots arranged in longitudinal lines.*—Fallow deer and Indian spotted deer; young tapirs; the paca (*Cœlogenys*) among the rodents; and the dasyures among the marsupials. Both in young tapirs and the paca the spots tend to coalesce into more or less complete longitudinal stripes,

5. *Mammals with white transverse bands.* — The kudu, eland, bongo (*Tragelaphus angasi*), and harnessed antelope (*T. scriptus*), among the antelopes, and Gunn's bandicoot (*Perameles gunni*) and the banded anteater (*Myrmecobius*) among the marsupials. In the harnessed antelope spots occur as well as stripes.

Many other species might be incorporated in these lists, but the foregoing instances are sufficient to show that no one type of coloration is confined to any particular group, although it may be much more common in one assemblage of animals than in another.

Several attempts have been made to reduce the coloration of animals to some general law, and among these one of the most notable was published some years ago by Prof. Eimer, of Tübingen, who based his conclusions on a comprehensive study of vertebrates in general. As the result of his investigations, this observer declared that the following laws might be laid down in regard to colour-markings of animals in general. Firstly, the primitive type of coloration took the form of longitudinal stripes. Secondly, these stripes broke up into spots, retaining in many cases a more or less distinct longitudinal arrangement. Thirdly, the spots again coalesced, but this time into transverse stripes. And fourthly, all markings disappeared, so as to produce a uniform coloration of the whole coat. As a further development of this theory, it was added that the more specialized features were assumed in many cases more completely by the male than the female, while the primitive coloration often persists in the young. And it was stated that the primitive longitudinal stripes frequently persist on the middle of the back, and likewise on the crown and sides of the face; examples of the latter survival being shown by the head and face-stripes of many spotted cats, and the dark and light streaks on the sides of the face of the badger.

Whether these laws hold good for other groups of vertebrates, it is not within the scope of the present article to inquire, and attention will accordingly be concentrated on mammals. If they be true, we should, *primâ facie*, expect to find a large number of longitudinally-striped forms among the lower members of the class; while those of intermediate grades of evolution would be spotted, and the higher types either transversely striped or uniformly coloured. This, however, could only be the case, as a whole, if all mammals formed one regularly ascending series; whereas, as a matter of fact, they form a number of divergent branches, each containing specialized and generalized forms. The inquiry is thus rendered one of extreme complexity; although there ought, if the theory were true in its entirety, to be a considerable number of longitudinally-striped species among the lowest groups of all. Unfortunately, palæontology, from the nature of the case, can afford us no aid, which fact very materially adds to the difficulty. It may be added that in Prof. Eimer's scheme no distinction is drawn between light and dark markings—that is to say, between the total disappearance of pigment and an ultra-development of the same—and it is obvious that this may be of such prime importance that these two types of coloration have nothing whatever to do with one another. Nevertheless, we may provisionally consider light and dark stripes, and light and dark spots, as respectively equivalent to one another.

With regard to uniformly coloured animals, there can be no question as to the truth of the theory, since the young of so many animals, such as lions, pumas, deer, pigs, and tapirs show more or less marked striped or spotted markings which disappear more or less completely in the adult. The occurrence of bands on the legs and sometimes on the shoulders of mules and dun-coloured horses, and likewise the presence of dark bars on the limbs of otherwise uniformly-coloured species of cats, like the Caffre cat and the bay cat, are further proofs of the same law. Moreover, the fact that in the young of pigs—and to a certain extent those of tapirs—the markings take the form of longitudinal stripes, whereas in the more specialized deer, whether young or old, they are in the shape of spots arranged in more or less well-defined lines, is, as far as it goes, a confirmation of the theory that spots are newer than stripes. And the presence of transverse stripes in the still more highly specialized antelopes tends to support the derivation of this type of marking from spots, especially if it be remembered that the harnessed antelopes are partly spotted. Still, it must be borne in mind that these instances apply only to light markings, which, as already stated, may have a totally different origin from dark ones.

There are, however, apparently insuperable difficulties as regards longitudinal and transverse striping in mammals. In the first place, instead of finding a number of the polyprotodont, or more primitive marsupials, showing longitudinal stripes, we have in this group only the three-striped and single-striped opossums thus marked, and in these the stripes are respectively reduced to the numbers indicated by their names. This, however, is not all, for the banded anteater—the most primitive of all living mammals (with the exception of the egg-laying mammals)—takes its name from the narrow transverse white stripes with which the back is marked; while the thylacine (Fig. 1), which cannot in any sense be regarded as a specialized type, is similarly marked with broader dark stripes; neither of these animals having any trace of a longitudinal stripe down the back. The water-opossum, again, may be regarded as a transversely-striped marsupial, although here the stripes are few in number, and approximate in form to blotches. Although in the same order the dasyures are spotted with white, we have no black-spotted marsupial; and if such a type formed the transition between longitudinal and transverse stripes, surely some species showing such a type of coloration ought to have persisted.

Then, again, in the ungulates we have the zebra-antelope, the gnus, and the zebras showing most strongly-marked transverse dark stripes; but we have no dark-spotted forms in the whole order except the giraffes, while the only ones with dark longitudinal stripes are young pigs. And it would thus appear that, although all the animals above mentioned are highly specialized species

these transverse stripes and dark blotches must have originated *de novo* quite independently in each of the groups in question. Indeed, when we remember that the coloration of both the zebras and the giraffes is generally stated to be of a protective nature—the stripes of the former rendering the animals invisible on sandy ground in moonlight, and to a great extent also in sunlight, while the blotches of the latter harmonize exactly with the checkered shade thrown by the mimosa trees among which they feed—it is incredible that both types should have been evolved, according to a rigid rule, from animals marked by dark longitudinal stripes.

Another instance of the same nature is afforded by the cats, in most of which the coloration appears to be mainly of a protective nature; plain-coloured species, like the puma and lion, having tawny coats harmonizing with the sandy deserts which these animals often inhabit, while the vertical stripes of the tiger resemble the perpendicular lights and shadows of a grass jungle. The clouded markings of the marbled cat and clouded leopard assimilate with the boughs on which these species repose, and the spotted pelage of the Indian desert cat renders the creature almost invisible in stony deserts. To suppose that all such adaptations have been produced in the regular order required by the theory is as incredible as in the last case. There is, moreover, the circumstance that the young of the uniformly-coloured puma are spotted, thus giving an instance of the direct passage from a spotted to a plain-coloured form without the intervention of a transversely striped stage; precisely the same thing also occurring in the case of the deer.

If we look for the most primitive mammals with longitudinal dark stripes over the greater part of the upper surface, such types being wanting in the marsupials, we shall find them in the striped mangooses (*Galidictis*) of Madagascar, already mentioned. And as the civets and allies are certainly the most generalized of existing carnivora (although that order occupies a somewhat high position), this case tends, in a certain degree, to lend some support to the view that longitudinal dark stripes are an early type. The rarity of animals exhibiting this pattern over all their bodies, coupled with the frequent retention of a longitudinal dorsal stripe, are likewise in some degree confirmatory of the same view. With regard to the conspicuous black and white stripes on the cheeks of the badger, and throughout the head and body in the skunks, South African weasel, and Cape polecat, it may also be argued, with some show of reason, that we have an old type of coloration. In the ancestors of the badger such a type may have been found too conspicuous, and accordingly have been removed except from the face; whereas in the other forms, all of which are more or less evil-smelling creatures, a conspicuous coloration is an advantage, as warning off other animals from attacking them in mistake for harmless kinds, and the boldly alternating stripes have accordingly been retained and rendered as conspicuous as possible.

Did space permit, we might dilate to almost any extent on the subject of spots and stripes; but sufficient has, we hope, been said to indicate the interest attaching to the coloration of mammals, and to show how far we are from understanding the causes and modes which have brought about the present state of things. That uniformly-coloured mammals form the climax of colour-evolution in the case of stripes and spots may be pretty safely admitted. It may further be considered probable that longitudinal dark stripes are an old type of coloration in at least some groups, although it does not follow that this will hold good for all, the marsupials being possibly an exception. Transverse stripes cannot, however, be made to accord with Prof. Eimer's theory, since not only do they exist in some of the most primitive of all mammals, but they reappear in certain specialized groups where there is no evidence of a previous spotted stage having been passed through. While, therefore, far from improbable that there may be a certain substratum of truth in what we may call the "longitudinal-spotted-transverse-uniform" theory of coloration, we submit that in its present guise it cannot adequately explain the whole evolution of "spots and stripes in mammals."

SURREY: ITS GEOLOGICAL STRUCTURE.

By Prof. J. LOGAN LOBLEY, F.G.S., &c.

THE County of Surrey strikingly exemplifies the remarkably diverse geological structure of the British Islands, in which comparatively small area there are represented nearly all the sedimentary rocks of the globe, for in this southern county with an area of only 486,039 acres, or about 760 square miles, no less than a dozen of the recognized geological formations are to be found. These are in ascending order as follows: the Hastings Sands, the Weald Clay, the Lower Greensand, the Gault, the Upper Greensand, the Chalk, the Thanet Sands, the Woolwich Beds, the Oldhaven Beds, the London Clay, the Bagshot Sands, Pleistocene Deposits, and Alluvium.

Surrey also affords an excellent illustration of the intimate connection between surface configuration and geological structure, since the physical divisions of the area are each coincident with the topographical extension of geological formations. These physical divisions, seven in number, are very distinct and will be readily recognized. They are (1) the undulating country lying between the eastern half of the Surrey Downs and the Thames, (2) the Downs area extending east and west through the whole length of the county but of varying breadth, (3) the long vale or succession of vales immediately to the south of the line of Downs called Holmesdale, (4) the western expansion of the southern boundary ridge of the Holmesdale vale, (5) the north-western broad expanse of heath-lands, (6) the plain that forms the southern side of the county, and (7) the south-eastern upland area contiguous to Kent and Sussex. These areas are conspicuously different in surface configuration and in soils, in aspect and productions, and have each an entirely different geological structure.

The last named of the seven areas, at the south-east of the county, is on the oldest rocks of Surrey, the Hastings Sands, which rise at Dry Hill Camp to 564 feet above Ordnance Datum. The beds represented are the Lower and Upper Tunbridge Wells Sands, with the intermediate Grinstead Clay, which, however, has but a small outcrop. The whole area is inconsiderable in extent, but affords from its elevated surface and rich surroundings beautiful scenery.

The extensive and richly-wooded plain stretching along the Sussex border is the Surrey portion of the great Weald Vale, that extends through Kent eastwards to the sea. It is wholly formed by the Weald Clay, which, however, is covered in many places by superficial gravels. In Saxon times this area was covered by a dense forest of oaks, the Forest of Anderida, and even at present the timber is largely oak, which tree flourishes generally on clays. The ancient forest was greatly cleared by the felling of the trees for the production of charcoal, much of which was employed for smelting the ironstone of the Weald, an ore that was largely used for iron previous to the present century. The Weald Clay was estimated by Mr. Topley to have a thickness

of no less than 1000 feet near the foot of Leith Hill, all the result of the accumulation of estuarine or delta deposits.

Slight undulations in the Weald plain indicate the presence near the surface of thin bands of hard limestone which in places contain fossil shells, *Paludina*, so abundantly that it forms an ornamental stone or marble. The surface levels range from 150 feet above Ordnance Datum to over 350 feet at Holmwood Common, on the flanks of the northern bounding uplands. From the impervious character of clay, the whole plain is well watered by rivers and minor streams. The Mole, the Wey, and the Eden each derive much water from its surface drainage, and the northern affluent of the Sussex Arun rises from its northern edge at the foot of Leith Hill.

The heath district, forming the north-western part of the county, from its generally sterile and open character, contrasts strongly with the Weald Clay Plain, where parks and woodlands alternate with small enclosures surrounded by luxuriant hedges and abundant hedgerow timber. Underlying the whole of this extensive area are the Bagshot Sands, either lower, middle, or upper, which are of Middle Eocene age. As some of the beds, especially in the Middle Bagshot, are argillaceous, the sterility of the surface soils is not uniform; for where clayey beds occur at or near the surface, greater moisture gives a richer vegetation. Extensive sandy tracts, however, heath-covered and unenclosed, and dark pine woods, are the general characteristics of this remarkable district. Its surface is undulating and generally moderately elevated, attaining the following summit levels above Ordnance Datum: The Fox Hills, near Chertsey, 235 feet; Chobham Common, 243 feet; Frimley Ridges, 376 feet; the Fox Hills, near Ash, and Romping Downs, 390 feet; and Bagshot Heath, 426 feet. The hills are in places covered with gravels, and large blocks of hard sandstone, called Sarsden stones, resulting from concretionary action, are found at and immediately below the surface.

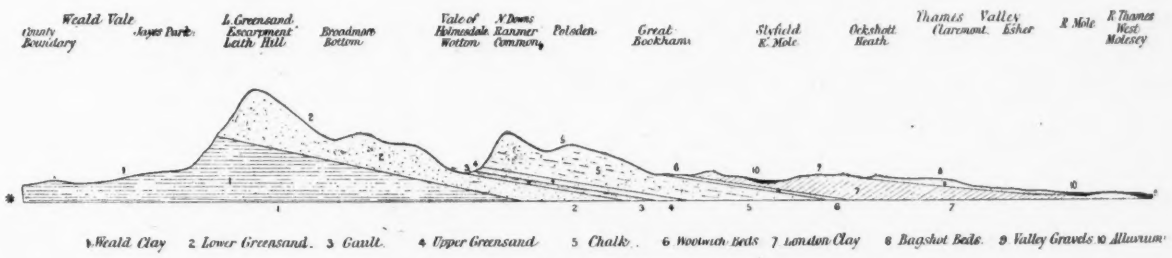
Much higher land gives large areas in the western expansion of the ridge bounding Holmesdale on the south. It culminates in Leith Hill, 965 feet above Ordnance Datum, and the highest land between the Thames and the sea, and rises to 852 feet at Hindhead. The whole of this area is formed by the Lower Greensand, the uppermost member of which—the Folkestone Beds—constitutes the highest ground and gives the largest area. A considerable acreage is occupied by dense woods, as Hurtwood and the woods of Leith Hill, and open commons, as Hindhead and Frensham Commons, and Blackheath and Farley Heath. The district also comprises Wotton, the ancestral seat of the Evelyns, a richly-wooded demesne as becomes the home of the author of "Sylva," Holmbury, Abinger, and Albury Parks, and many other beautiful estates. The ground slopes gently to the north in accordance with the dip of the strata, but has a steep slope to the south, forming a very pronounced escarpment.

The long and very beautiful vale of Holmesdale, lying on the northern side of the Lower Greensand ridge and having the lofty Downs dominating it on its northern side, though nearly forty miles long, has a general breadth of one or two miles only. The vale bottom rests upon a narrow outcrop of the Gault Clay which overlies the Lower Greensand, and like it dips to the north at a low angle. On this clay, too, oaks are abundant, surface water plentiful, and the ground of a dark colour, giving to its soils the name of "black-land."

But the most conspicuous feature of the whole area of the county is that formed by the long range of hills called the North Downs, which is continued through the neighbouring county of Kent and terminates eastwards only at Dover Castle. Though not attaining the elevation of the Lower Greensand ridge at Leith Hill, it is nevertheless of greater average height, and at Botley Hill the summit level is 881 feet above Ordnance Datum. At the Hog's Back, between Farnham and Guildford, the breadth of the hill is only about half a mile, but eastwards of Guildford the Downs broaden to no less than seven miles at Banstead. Like the Lower Greensand area, this elevated land has a gentle slope to the north and a steep escarpment to the south, at some points the inclination being upwards of sixty degrees, as at Box Hill. The outlines of the range are a series of singularly soft and gentle curves, and in many places the hills display beautifully rounded indentations called Combes, that are carpeted with the most velvet like verdure. Crossing the range in Surrey and dividing it into three well-defined sections are two deep valleys or gorges, through which run the two rivers, the Wey and the Mole, on their northern course to the Thames.

The Downs area is entirely formed by the great Chalk formation which dips to the north conformably to the underlying beds. The northern slopes and the summit levels are consequently on the Upper Chalk, the Lower Chalk only being seen on the face of the steep southern escarpment, at the base of which the Upper Greensand, with a very narrow outcrop, overlies the Gault. Over large areas the Chalk, especially at the higher levels, is covered with superficial beds of clay and loam or brick-earth, which support more luxuriant vegetation and finer timber than grow on the uncovered chalk, and so give many parks and woods of great beauty at high levels. The yew, the box,

Section across Surrey, from the Sussex boundary to the River Thames, showing the general geological structure.
Length of Section, twenty miles. The Vertical Scale ten times the Horizontal Scale.
(A Section more to the East would show the Lower Greensand Escarpment, lower than the Chalk Escarpment of Leith Hill.)



the juniper and the holly may be found in many places on the chalk soils growing indigenously, and a really primeval forest of these trees may be seen to-day so near London as the slopes of Riddlesdown, at Kenley.

From the very absorbent character of chalk the Downs form, speaking generally, a streamless area, except after unusually wet seasons, when a few streams flow for a time, the result of the plane of supersaturation of the chalk rising above valley bottoms. The Kenley Bourne is perhaps the most noteworthy of these intermittent streams. The following are summit levels along the Surrey Downs from west to east:—The Hog's Back, 503 feet; Albury Down, 625 feet; Netley Heath, 674 feet; White Downs, 723 feet; Box Hill, 644 feet; Headley Heath, 619 feet; Buckland Hills, 708 feet; Colley Hill, 732 feet; Reigate Hill, 762 feet; Gravelley Hill, 777 feet; Tandridge Hill, 791 feet; Woldingham Down, 816 feet; Botley Hill, 881 feet.

The Chalk forming the North Downs, dipping as it does to the north and cut off abruptly on the south, is obviously but the northern remnant of a great sheet which extended across the entire Wealden area, and was continuous with the Chalk of the South Downs that dips in the opposite direction. The geological structure of the entire district gives an east and west main anticlinal through the middle of the Weald, throwing off the upper beds to the north and the south, and giving a great denuded surface of lower beds forming a central area.

North of the Downs lies the undulating and well-wooded area that is bordered by the Thames, and watered by the Wey, the Mole, the Hog's Mill River, the Beverley Brook and the Wandle. Some of this area near the Thames is very low, but it rises to 184 feet above Ordnance Datum at Richmond Hill, to 296 feet at Streatham Common, and to 379 feet at the Crystal Palace.

This is the Lower Eocene area of Surrey, and with the Bagshot district forms the Surrey portion of the London Tertiary Basin. The London Clay forms the great bulk of the area, the Woolwich Beds giving but a small breadth of land and the Oldhaven Beds a still smaller acreage, while the Thanet Sands have a very inconsiderable outcrop. At the lower levels, however, river gravels and brick-earths largely cover the London Clay, and bordering the Thames, the Wey and the Mole there are strips of Alluvium. Gravels over the London Clay form the surface at higher levels, as at Clapham, Wimbledon, and other commons, and even on the Norwood Hills there are patches of these superficial deposits.

From this varied geological structure of Surrey, hills and vales, level stretches and picturesque highlands, rich woods and smooth and swelling downs, parks and wastes, highly-cultured fertile lands and barren heaths, all combine to form this beautiful southern county, while, flowing through a world-renowned vale, the silver Thames winds for fifty miles along its northern side.

We read in *Cassier's Magazine* that the smallest generator of electrical or mechanical energy in the world is a battery constructed by one of the electricians of the Boston Telephone Company, consisting of an ordinary glass head, through which two wires, one of copper and the other of iron, are looped and twisted so as to prevent their coming in contact. The wires act as electrodes, and a drop of acidulated water in the head causes a current to flow. It has been used in signalling to a distance of nearly two hundred miles.

*** The picture of "The Spider's Web" in the December number of KNOWLEDGE was taken from a photograph kindly supplied by the Rev. H. D. Nicholson, of Tavistock.

IT is with the deepest regret that we have to announce the death of Mr. ARTHUR COWPER RANYARD, the Editor of KNOWLEDGE. Mr. RANYARD died at his residence in Bloomsbury, on Friday evening, December 14th, 1894.

THE CONSTRUCTION OF THE VISIBLE UNIVERSE.

By J. E. GORE, F.R.A.S.

AN examination of the evidence we have at present, with reference to the distribution of the visible stars in space, has recently been undertaken by Prof. Kapteyn of Groningen, and a popular account of the conclusions he has arrived at may prove of interest to the general reader.

It must first be explained that, in order to obtain a clear view of the construction of the visible heavens, it would be necessary to know the relative distances of a large number of stars; but as the distances of only a few stars have yet been determined, and the results hitherto obtained are open to much uncertainty, we must have recourse to some other method of estimating these distances. In travelling in a railway carriage, if we fix our attention on the trees, buildings, and other objects we pass on our journey, it will be noticed that all objects apparently move past in the opposite direction to that in which we are travelling, and that the nearer the object is the faster it seems to move with reference to distant objects near the horizon. So it is with the stars. The sun is moving through space, carrying along with it the earth and all the planets, satellites, and comets forming the solar system. The effect of this motion is to cause an apparent small motion of the stars in the opposite direction, and the nearer the star is to the earth the greater will this apparent motion seem to be—as in the case of the railway train. In addition to this apparent motion, the stars are themselves—like the sun—moving through space, and this *real* motion is also visible. If this *real* motion takes place in the *opposite* direction to that in which the earth is moving it will add to the apparent motion, and will increase the "proper motion," as it is termed. If, on the other hand, the real motion is in the same direction as the earth's motion, it will tend to diminish the proper motion. In either case, the nearer the star is to the earth the greater will be its apparent annual displacement on the background of the heavens. The amount of the "proper motion" is, therefore, considered by astronomers to form a reliable criterion of the star's distance from the earth, and the actual measures of distance which have been made show that this assumption is approximately true. Of fourteen stars which have a proper motion of over three seconds of arc per annum, eleven have yielded a measurable parallax, or displacement due to the earth's annual motion round the sun—that is to say that eleven out of fourteen fast-moving stars are within a measurable distance of the earth, and therefore near us when compared with the great majority of the stars which are not within measurable distance, or, at least, are beyond the reach of our present methods of measurement.

In the case of small groups of stars, we may assume that the real motions of the individual stars take place

indifferently in all directions, and that consequently, taking an average of all the motions of the stars composing the group, the effects due to the real motions will destroy each other, and there will remain as the most reliable criterion the effect due to the sun's motion in space. If, however, we compare the proper motions of groups situated in *different parts* of the sky, there is a consideration which to a great extent vitiates this conclusion. For, near the point of the heavens towards which the sun and earth are moving known as the *apex* of the solar way, and situated about seven degrees south of the bright star Vega, as indicated by recent researches, and near the point *from* which the sun is moving—known as the *ant-apex*, about fifteen degrees south of Sirius—there will be no apparent displacement due to the solar motion through space, as this motion takes place in the line of sight with reference to these points of the sky. The observed proper motion at these points will, therefore, be solely due to the real motion of the stars in those regions. In other parts of the heavens, however, the total proper motion will be a combination of the apparent and real motions of the stars, and for stars in *different* parts of the heavens it will not follow that stars having equal proper motions are necessarily at the same distance from the earth. To make this point clearer, let us assume that there are two stars at absolutely the same distance from our eye, one situated at or near the solar apex and the other at a point ninety degrees from the apex, and let us suppose that both are moving through space with exactly the same velocity, and in the same direction, say at right angles to the direction of the solar motion. Then, in the case of the star near the apex, the observed "proper motion" will be solely due to the star's *real motion*, and in the star ninety degrees distant from the apex the "proper motion" will be solely due to the solar motion. Now, unless the stellar motion and the solar motion happen to be equal, the observed "proper motions" will not be equal, although both stars are at the same distance from the earth. If both stars are really at rest, the star at the *apex* will have no proper motion, while the star ninety degrees distant will have an apparent proper motion due to the sun's motion. To overcome this source of error in estimating the distance of a star from its proper motion, Prof. Kapteyn made use of another measure which is independent of the solar motion. This is the component of the proper motion measured at right angles to a great circle of the sphere passing through a star and the solar apex. The amount of motion in this direction will evidently not be affected by the sun's motion, and from a discussion of the stars contained in the Draper Catalogue of Stellar Spectra, which were observed by Bradley (and of which the proper motions are consequently now known with accuracy), Prof. Kapteyn finds that this motion is "nearly inversely proportional to the distance," that is, the greater the motion the less the distance of the stars, and the smaller the motion the greater the distance. Excluding stars with proper motions greater than half a second of arc per annum, Prof. Kapteyn found that for stars at various distances from the Milky Way this component of the "proper motion" forms a good measure of distance.

As the result of his investigations on this interesting question, Prof. Kapteyn arrives at the following conclusions.

Neglecting stars with small or imperceptible proper motions, we have a group of stars which no longer show any condensation in a plane. Stars with very small or no proper motions show a condensation towards the plane of the Milky Way. This applies to stars of the second or solar type as well as to those of the first or Sirian type of spectrum, and evidently indicates that the stars composing the Milky Way lie at a great distance from the earth. The extreme faintness of the majority of the stars composing the Galaxy seems to confirm this conclusion. The condensation of stars of the first type is more marked than those of the second, and this agrees with the fact which has been noticed by Prof. Pickering, that the majority of the brighter stars of the Milky Way show spectra of the first or Sirian type, and, judging from the ease with which the fainter stars of the Galaxy can be photographed, he concludes that most of these fainter stars are bluish, and probably have spectra of the first type, like Sirius and Vega, which are bluish-white stars. From an enumeration of the stars included in the Dorpat Catalogue, I find that sixty-three per cent. of the stars of the Milky Way, as drawn by Heis, have spectra of the Sirian type.

Prof. Kapteyn finds that this condensation of stars with small proper motions is very perceptible even for the stars visible to the naked eye, and is as well marked in those stars which have spectra of the second type as for all the stars of the ninth magnitude, but for stars of the first type the condensation is still more marked. He considers that this condensation is either partly real or that there is a real thinning out of stars near the pole of the Milky Way. As I have shown elsewhere, M. Celoria's observations with a small telescope, compared with Sir William Herschel's observations with a large telescope, indicate clearly that there is a *real* thinning out of stars at the poles of the Milky Way.

Prof. Kapteyn concludes that the arrangement of the stars suggested by Struve has no real existence. He attributes the fallacy in Struve's hypothesis to the fact that the mean distance of stars of a given magnitude in the Milky Way, and outside it, is not the same.

Prof. Kapteyn finds that the vicinity of the sun is almost exclusively occupied by stars of the second or solar type, a conclusion which reminds us of Dr. Gould's "solar cluster." He finds that the number of Sirian type stars increases gradually with the distance, and that beyond a distance corresponding to a proper motion of about one-fourteenth of a second per annum the Sirian stars largely predominate.

In the group of stars known as the Hyades, however, the components of which have a common proper motion both in amount and direction, stars of the first and second types appear to be mixed, and Prof. Kapteyn assumes that the two types represent different phases of evolution, and that as the brightest stars of the group are chiefly of the solar type, these stars must be the largest of the group. From this fact he concludes that the solar type stars are in a less advanced stage of evolution than those of the Sirian type. This does not agree with the generally accepted view. Thus Prof. Vogel considers the Sirian stars to represent the earlier stage of stellar evolution. Mr. Proctor held the same opinion, and in Prof. Lockyer's hypothesis of increasing and decreasing temperatures in stars of various types he places the Sirian stars at the summit of the curve, and the sun and solar just below them on the descending branch of the curve ("The Meteoritic Theory," pp. 380, 381). These hypotheses are in conformity also with the current opinion that the sun is a cooling body. This discrepancy may perhaps be explained by supposing that the *brighter* stars of the Hyades form a connected group, and that some, at least, of the fainter stars do not belong to the group, but are situated at a great distance behind it. In the case of the Pleiades, which form a much more evident cluster, I find from the Draper Catalogue that the great majority of the

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brighter stars have spectra of the Sirian type. Most of the stars in the Pleiades have a very similar proper motion, both in direction and amount, and there can be no doubt that they form a connected system. The superior brilliancy of the stars composing the Hyades would indicate that they are nearer to the earth than the Pleiades group, and they may possibly form members of the "solar cluster."

Assuming that the distances are inversely proportional to the proper motions, Prof. Kapteyn computes the relative volumes of the spherical shells which contain the stars with different proper motions (from one-tenth of a second to one second of arc, and more). Comparing these volumes with the corresponding number of stars, we arrive at an estimate of the density of star distribution at various distances. The result of this calculation shows that the distribution of stars of the Sirian type approaches uniformity when a large number of the faint stars (the ninth magnitude) are considered. With reference to stars of the second type, however, the larger the proper motion the greater the number of the stars, or, in other words, the second type or solar stars are crowded together in the sun's vicinity. Evidence in favour of this conclusion is afforded by the fact that of eight stars having the largest measured parallax (and whose spectrum has been determined), I find that seven have spectra of the solar type. The exception is Sirius, which is evidently an exceptional star with reference to its brightness and comparative proximity to our system, no other star of the first magnitude having nearly so large a parallax. Indeed, the average distance of all the first magnitude stars in the heavens has been found to be over forty times the distance of Sirius.

Prof. Kapteyn finds that the centre of greatest condensation of the solar type stars lies near a point situated about ten degrees to the west of the great nebula in Andromeda, and that this centre nearly coincides with the point which, according to Struve and Herschel, represents the apparent centre of the Milky Way considered as a ring. This would indicate that the sun and solar system lie a little to the north of the plane of the Milky Way, and towards a point situated in the northern portion of the constellation of the Centaur. The fact is worth noting that the nearest fixed star to the earth, Alpha Centauri, lies not very far from this point. Possibly there may be other stars in this direction having a measurable parallax. The southern portion of the heavens has not yet been thoroughly explored.

Prof. Kapteyn finds that, for stars of equal brightness, those of the Sirian type are on an average about two and three-quarter times further from the earth than those of the solar type. As light varies inversely as the square of the distance, this would imply that the Sirian stars are intrinsically over seven times brighter than those of the solar type. This conclusion is confirmed by the great brilliancy of Sirius, and other stars of the same type, in proportion to their mass. I have shown elsewhere that Sirius is about forty times brighter than the sun would be if placed at the same distance, although its mass is only twice the mass of the sun, as computed from the orbit of its satellite.

The general conclusions to be derived from the above results seem to be that the sun is a member of a cluster of stars possibly distributed in the form of a ring, and that outside this ring, at a much greater distance from us than the stars of the solar cluster, lies a considerably richer ring-shaped cluster, the light of which, reduced to nebulosity by immensity of distance, produces the Milky Way gleam of our midnight skies.

THE NEW SOLAR RECORDS.

By E. WALTER MAUNDER, *Hon. Sec., R.A.S.; President, British Astronomical Association; Superintendent of the Physical Department, Royal Observatory, Greenwich.*

FROM the point of view of astronomical physics, no celestial body demands so much study as the sun, and none repays it better. A star amongst the stars, it reveals to us at a comparatively near view the lines upon which general stellar anatomy is constructed. The most vigorous and active member of the solar system, it supplies hints to us of what in the distant past was the condition of our own world and of the other members of the planetary family. And as the great source and maintainer of nearly all the energy of the solar system, it would be an object of surpassing interest, even if it had nothing to reveal to us of any other body in the universe.

And so, from the very first invention of the telescope, solar physics have formed an important department of astronomy. But the present century has been specially rich in persevering and devoted observers. Schwabe, who discovered the periodicity of the sunspots; Wolf, who carried Schwabe's record onward, and followed it backward, so as to extend the sunspot curve over two centuries and a half; Carrington, who determined the solar rotation period and its change with the latitude, and corrected the elements of the solar axis; Spoerer, who brought out the relation of the distribution in latitude of sunspots to the phases of the sunspot cycle; these stand out as leading names amongst those who used the visual method of observing, or who discussed the results obtained by that method.

To Warren De la Rue we owe the important advance of the employment of photography for obtaining records of the solar surface. Great as is the skill to which many observers have attained in drawing sunspots, and though the best drawings still outstrip all but two or three very exceptional photographs as to the delicacy of the detail they show, still the photographs much surpass the drawings as to the fulness and the accuracy of their record.

These earlier photographs, and those still taken at Greenwich and elsewhere, were of course taken by means of the general light of the sun—chiefly by means of the blue and violet rays. It is substantially a picture of the photosphere that they give us, precisely as eye drawings do.

But the ingenuity of Mr. Hale and M. Deslandres has recently supplied us with a new class of solar photographs—photographs by monochromatic light; photographs which no longer give us a record of the solar photosphere, of that incandescent cloud surface from which the white light of the sun proceeds, but of certain specific luminous gases in the solar atmosphere.

The principle upon which the instruments for obtaining these new records are based is sufficiently simple, the necessary mechanical adjustment much more difficult. Substantially it amounts to this: A spectroscope is arranged, having not merely a slit in the focus of its collimator, but another in the focus of its viewing telescope. The second slit can be so arranged as to correspond to the place of any selected line in the spectrum. Now, if a photographic plate be placed behind the second slit, it will receive from the sun light only of the wave-length selected.

In the ordinary form of photo-heliograph the exposure is usually given by drawing a narrow slit rapidly across the image of the sun in the primary focus, and the various portions of the sun, exposed in this way in rapid succession, build up a complete image on the sensitive plate. In the spectro-heliograph, as just said, the light of one particular

wave-length is allowed to pass the second slit; the light, therefore, is far feebler than that used in the ordinary photo-heliograph, where the entire light of the sun, undispersed, is used. What is required, then, is to slowly move the entire spectroscope, the first slit travelling across the sun's image, the second across the plate, and an image of the sun as given by light of the wave-length in question is built up on the plate. In practice there are several ways of effecting this result, one of the most convenient being to fix the spectroscope, allowing the sun to transit across the first slit while the plate itself is moved by clockwork at the requisite speed behind the second slit.

In this way Mr. Hale and M. Deslandres have supplied us with photographs of the sun produced by the light of the K line, the new method having suggested itself to them from the fact that their photographs of the solar spectrum showed that the H and K lines were bright in the spectra of faculæ. And, as is shown by the two upper photographs of the four in the accompanying plate, such photographs display a network of bright markings extending across the disc, and closely resembling in character the faculæ which we see directly in the telescope, or photograph in an ordinary photo-heliograph.

Moreover, a comparison of these two photographs with those taken on the same days, 1894, April 10th and 11th, at Greenwich, shows that to a certain extent the ordinary faculæ and these bright K line districts actually correspond. Thus the bright region at about position-angle 240°(from the north extremity of the sun's axis, *not* from the north point) on Fig. 1, and still closer to the limb on Fig. 2, corresponds in position to a group of faculæ on the Greenwich photographs. So, again, the bright region a little to the north-east of the one just mentioned has its correlative on the plates taken with the ordinary photo-heliograph. Representatives can also be traced of the great stream of brilliant K matter in N. lat. 17° or 18°, and stretching from the central meridian almost to the west limb. And the bright cluster about position-angle 115° is also represented, and represented not merely as to general position, but as to form and extent.

But this correspondence between the bright regions on the photographs taken with the photo-heliograph and the spectro-heliograph is not exact. The spectro-heliograph does not merely show us what we should see if we made a rapid circuit of the sun, and noted the faculæ revealed near the limb as the visible hemisphere shifted its boundary to our gaze. The K line faculæ—if, from their appearance, we may so call the faculous-looking regions on these photographs—are not the same as the faculæ shown on an ordinary photograph. The two are clearly connected; they are as clearly not identical.

To take the most striking instance in the photographs before us, the great solid mass of K faculæ in the northern hemisphere and on the central meridian. This region, on the ordinary sun-picture, is the site of a fine train of spots, stretching over 18° of solar longitude, and with a breadth of $5\frac{1}{2}$° of solar latitude, and an area of 860 millionths of the hemisphere on April 10th, which has increased to 980 millionths by April 11th. Or, translating these elements into English miles, the greatest length of the group is very nearly 100,000 miles, its greatest breadth more than 40,000 miles, its area on April 10th 1000 million square miles, and on April 11th 1160 million square miles.

This train of spots is, indeed, represented on M. Deslandres' photographs by a few small spots, but the great body of the train is covered up from us by the mass of K faculæ.

Similarly, the group of K faculæ first mentioned, near position-angle 240°, is associated with a group of spots, which it partly covers. The K facula has a distinctly larger area than the corresponding facula on the ordinary sun-picture, and as the facula is close to the limb we cannot ascribe its smaller area on the Greenwich photograph to its unfavourable position. If it had been of equal area on the two photographs it would have appeared to us so.

The K faculæ shown us by the spectro-heliograph are, therefore, not merely the ordinary faculæ, but are something more. Since ordinary faculæ have the K line bright in their spectra, the spectro-heliograph enables us to photograph them, not merely near the limb, but wherever they may be on the disc. But over and above such faculæ, it shows us another class of faculæ more extensive than the first.

The difference between the two classes is this. The ordinary faculæ shine principally with white light, they give out chiefly a continuous spectrum—a light and a spectrum in itself feebler than that of the photosphere, but appearing to be brighter when seen near the limb, because the faculæ lie above the greater part of that layer of relatively dark dust which causes the enfeeblement of the light near the sun's limb. They thus escape obscuration by it. For the most part they probably consist of incandescent solid matter, no doubt in a finely divided state; and because solid, they are opaque. An ordinary facula, crossing a spot, effectually hides from our view the region beneath it.

The K line faculæ, on the other hand, consist of glowing gas. They cover all the region occupied by the first class, but they also extend beyond, and especially so in the region of spots; and unlike ordinary faculæ, they do not hide the spots lying beneath them.

These spectrographs give us yet further information. For the K line is given under a triple form corresponding to three different layers of the solar atmosphere over the greater part of the disc. First, a very broad dark line; then a bright line superposed on the first, and not so broad; thirdly, a narrow dark line superposed on the second line, and so dividing it into two. The broad dark line corresponds to the "reversing layer," in close contact with the photosphere; the bright line to a region just above, *i.e.*, to the lowest hottest stratum of the chromosphere, the region represented, therefore, in M. Deslandres' photographs; the narrow dark line in the centre, to a region higher still. Over the spots, however, it is usual to find the bright K line single, not double; corresponding, that is, to the uppermost of the three layers. Not that it follows that the calcium vapour over a spot is higher than over the general disc; rather the reverse, that we have here a region of lowered temperature and pressure, and that the conditions necessary for the production of the broader bright line of the second layer are not present here.

The spectro-heliograph not merely reveals to us these K line faculæ over the disc, it shows us the chromosphere and prominences beyond the limb, and the originals of Figs 1 and 2 show a number of prominences surrounding the sun; but the exposure having been calculated for the general disc, they are only faint, and have been lost in the reproduction. Figs. 3 and 4, however, are copies of photographs taken on the same days as the first two, but with fuller exposure, and they accordingly show the prominence forms very distinctly. The central portion of the sun was shut out by a diaphragm, very slightly smaller than the solar image. The most interesting prominence is the one near the south pole, which has changed in so remarkable a manner between the times that the originals of Figs. 3 and 4 were taken; indeed, a great change took place between the time of Fig. 2, taken April 11th, 11h.

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29m., and that of Fig. 4, taken at 2h. 22m. on the same day.

It is curious to reflect that but for what we must call the happy accident of the nice adjustment of the apparent diameters of the sun and moon, it is highly probable that these spectographic photographs of the sun, taken by M. Deslandres and Mr. Hale, would have been the first intimation we should have had of the existence of chromosphere and prominences. The mean apparent diameter of the moon is distinctly smaller than that of the sun, being under 31½ minutes of arc as against a little over 32 minutes. Were it not, then, for the eccentricity of the orbits of earth and moon, we should never have a total eclipse at all. Even as it is, so nicely adjusted are the apparent diameters of the two bodies that it is not very uncommon for a central eclipse to be both annular and total; annular for those countries where the eclipse takes place near sunrise or sunset, total for those where it takes place near noon. That is to say, the slight excess in the distance from the moon of places near the circumference of the hemisphere in daylight, over places near the centre of that hemisphere, suffices to reduce the apparent size of the moon, from being a very little greater than that of the sun to being a very little less.

Were the orbits of the earth and moon circular, or were the moon of equal density to the earth, its mass and distance remaining unchanged, we should never have an eclipse. Its period and its tide-producing power would, under the latter hypothesis, remain the same. But its volume would be changed, its diameter being diminished by one-seventh. The greatest diameter it could ever possess, even when in the zenith and at perigee, would be only 29¼ minutes, 2¼ minutes of arc smaller than that of the sun, even at apogee. A total eclipse would then be an impossibility, for even under the most favourable circumstances possible only six-sevenths of the sun could be concealed.

Had this been so, the sun's corona would have been utterly unknown to us, and no one could have suspected the existence around the sun of so wonderful and *bizarre* an appendage. There is nothing in the appearance of the sun itself to suggest it. The disc shows a perfectly well-defined and regular outline, unbroken by any excrescences, except on the rare occasions when a facula makes a scarcely perceptible projection. And even if we had suspected the existence of such a body, we should have found it hopeless to search for it.

Nor should we have been much better off with regard to the prominences. These were first seen by Stannyan during the eclipse of 1706. Fraunhofer applied the spectroscope to astronomy in 1814; Kirchhoff interpreted the Fraunhofer lines in 1859. But though the existence of the prominences was known, though the spectroscope was in use, it was not until 1868 that they were actually seen in daylight. Indeed, Huggins had definitely described the method by which they were to be rendered visible more than two years before it was successfully put in practice. How long, then, would it have been before the method of observing chromosphere and prominences would have been stumbled upon if no one had known of their existence?

Probably the history of our knowledge of these appendages of the sun would have been somewhat as follows: Lockyer, Secchi, Young, and others would have drawn attention to the occasional reversal of the lines of hydrogen over sunspots. It is unlikely that by chance an observer would bring into his spectroscope both a brilliant prominence and one of the hydrogen lines at the same time; but with the increased application of photography to astronomy, the photographic spectra of sunspots would begin to be studied. Then the observation of Young, made some years ago, of the reversal of the H and K lines over a spot and in its neighbourhood, would have been confirmed, and later would have been extended to faculæ generally. This would have brought us down to the commencement of the work of Hale and Deslandres, who might not improbably have followed the same lines that they have done under existing circumstances; and by the use of the double-slit spectroscope, and the invention of the spectro-heliograph, they would have demonstrated to us, for the first time, the existence of the prominences.

It is scarcely possible to exaggerate the interest which such a discovery would have excited; yet the advance which would have been involved by the discovery of the prominences—previously undreamed of on the supposition we have made—would have been scarcely greater than that which the use of the double-slit spectroscope promises to us. We are able, by its means, to separate, as it were, one particular shell of the sun from all others; or rather to isolate one single gas in the solar atmosphere and to study it alone. M. Deslandres has photographed the sun by one of the bright spaces between two of the Fraunhofer lines that is to say, by purely photospheric light. The resulting picture corresponds, as we should expect, to that shown to our eye by the telescope, or on an ordinary photographic plate, but with the differences in brightness between the spots and faculæ and the general disc accentuated. Again, he has photographed the sun by the light of one or other of the Fraunhofer lines themselves; for these are of course relatively, not absolutely, dark; that is to say, he has photographed the reversing layer itself, by one or other of the gases contained in it, just as if the sun and its photosphere were removed. Finally, he has photographed the sun, as in the present photographs, by the light of the bright K lines, by glowing calcium vapour—that is, situated at the base of the chromosphere, but above the "reversing layer." It still remains to photograph the sun by the third and narrowest line of the triplex K line, and so obtain a record of a higher stratum yet of the solar atmosphere. The new solar records, therefore, offer us the prospect of a far more intimate acquaintance with solar structure than we could have ventured to hope for a few years ago.

PHOTOGRAPHS OF THE SOLAR CHROMOSPHERE.

By H. DESLANDRES.

[M. Deslandres, by whose courtesy we are enabled to submit to the readers of KNOWLEDGE the four accompanying photographs of the solar chromosphere, taken by him at the Paris Observatory, on April 10th and 11th, 1894, furnishes the following description of the instrument with which they were taken.]

The originals of the photographs were taken with the following apparatus:—

1. The Foucault siderostat, constructed in 1869.

2. An object glass of five inches aperture and three mètres focal length.

3. A spectro-heliograph, or registering spectrograph with two slits, adjusted to isolate the bright ray of calcium.

This spectrograph consists of a collimator fifty centimètres in length, a flint glass prism of sixty degrees, and an object-glass of one mètre focal length, so that the image on the plate is magnified, and is exactly five centimètres in diameter.

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SOLAR SPECTROGRAPHS. By Mons. H. Deslandres, of the Paris Observatory.

FIGS. 1 and 2.—Showing the regions on the disc where the K line is bright.

FIGS. 3 and 4.—The Chromosphere beyond the limb, and the prominences, as seen on the K line.

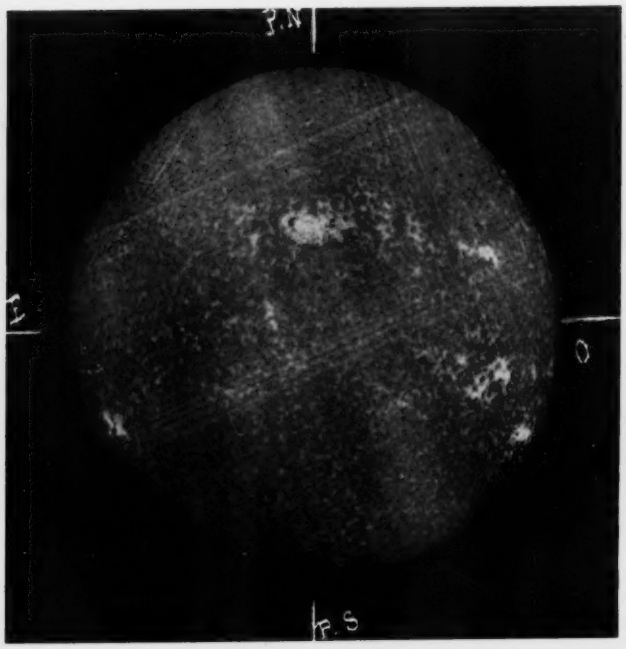

FIG. 1.—1894, April 10th, 11h. 30m, Paris Mean Time.

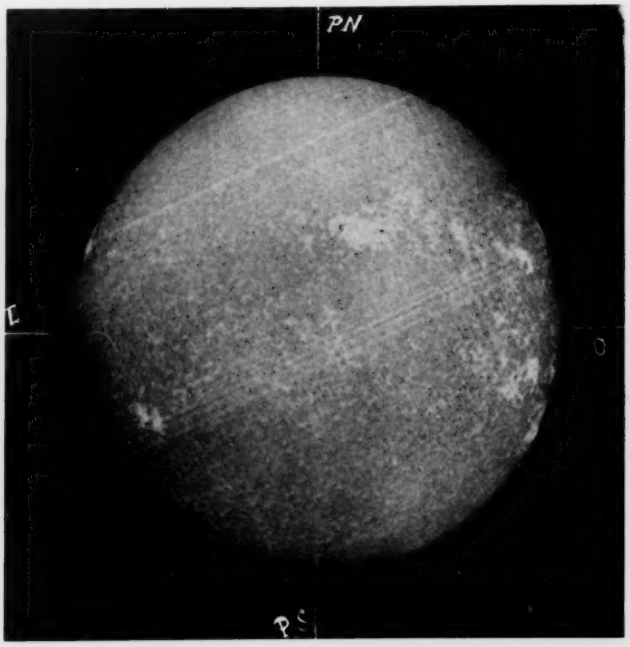

FIG. 2.—1894, April 11th, 11h. 29m., Paris Mean Time.

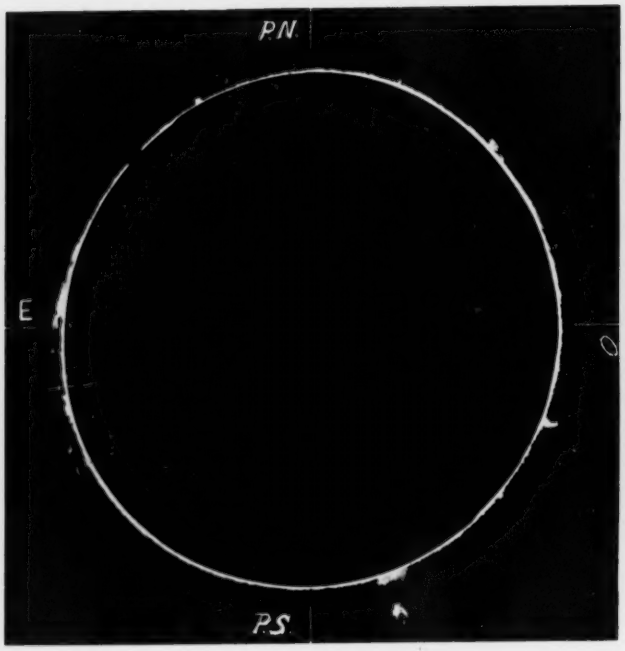

FIG. 3.—1894, April 11th, 2h 22m, Paris Mean Time.

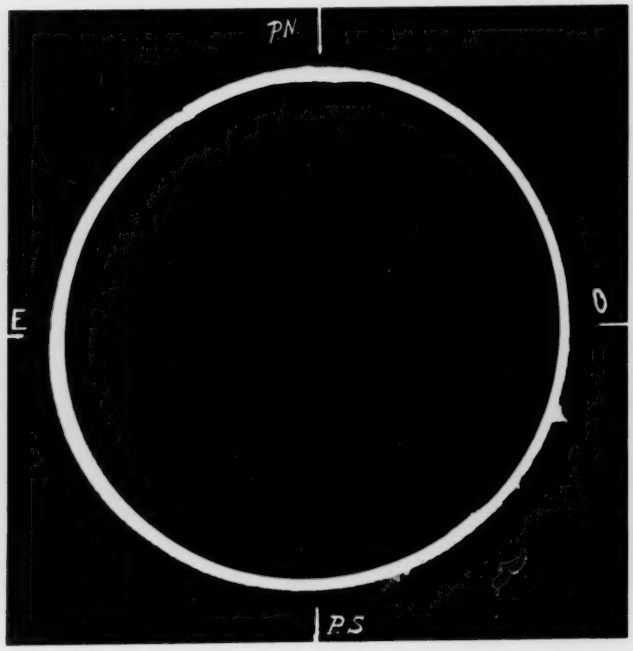

FIG. 4.—1894, April 10th, 11h. 3m., Paris Mean Time.

Direct Photo Engraving Co., 9, Barnsbury Park, N.

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The entire spectrograph, the two slits of which are firmly connected together, moves before the motionless image of the sun. It is driven by a clepsydra, and transmits a proportional movement to the sensitive plate by a single system of levers.

This arrangement has many advantages :

1. The small dispersion of the spectrograph, which is a necessary condition from the optical point of view, permits the greatest delicacy of detail to be obtained in the image, together with the exact intensity of the chromospheric flames, and also allows the flames of the centre, and the flames of the disc near the limb, which may be lost with a greater dispersion, to be equally well represented. 2. With the two slits fixed together, it is easy to obtain circular and not elliptical images, and there is no need to give the second slit a greater breadth than that of the line which it is desired to isolate. 3. The great focal length of the objective of the spectrograph makes the adjustment of the second slit easier, and gives an enlarged image without loss of light.

These photographs do not represent the faculæ, the images of which are slightly different, but the chromosphere itself above the solar disc.

The boundary of the photographs of the entire disc is not the true limb of the sun, but a slightly greater circle which includes the lowest and most intense parts of the chromosphere. When the exposure is sufficiently long, as in the present case, the prominences of strong and medium intensity also appear on the plate. They are better seen on the original negatives.

The two photographs showing the limb were taken with a longer exposure, and show all the prominences, and all parts of the chromosphere above the middle layer. The disc of the sun has been covered by a diaphragm, slightly smaller than it in diameter, to avoid diffusion of light.

PERIODICAL COMETS DUE IN 1895.

By W. T. LYNN, B.A., F.R.A.S.

TWO comets of short period are due to return to perihelion in the course of the present year ; but whereas one of these, which is in view whilst we write, has been seen at no fewer than twenty-six returns and consecutively since that of 1818-19, when it acquired its name from that of the illustrious astronomer who investigated its motions and calculated its orbit, the other has hitherto been seen at only one appearance.

The first comet is, of course, our old friend Encke, which was first discovered by Méchain at Paris on the 17th of January, 1786, and first seen at the present appearance on the 31st of October, 1894, at Nice, being then in the constellation Pegasus, very near the place predicted for it in the ephemeris of Dr. Backlund (*Astronomische Nachrichten*, No. 3263), who, we regret to notice, states that this is the last time that he will be able to undertake its calculation. The comet, he finds, will pass its perihelion on the 4th of February ; the last time it was in that position was on the 18th of October, 1891, on which occasion it made one of its very near approaches to the planet Mercury.

The other comet due in 1895 was discovered at its first appearance on the 16th of July, 1884, by Prof. Barnard, now of the great Lick Observatory in California, but who was then at Nashville, Tennessee. Although thus discovered in the northern hemisphere, the comet remained throughout that appearance in the southern. Dr. Gill and his assistants afterwards obtained a number of observations of it at the Cape of Good Hope, and it was also observed at Melbourne and other places, but was always very faint and difficult of observation. Its orbit was determined by Herr Berberich to be one of short period, amounting to only about five and a half years ; but its position at the return expected in the winter of 1889 was exceedingly unfavourable, and it was not seen. Another appearance will be due in the summer of the present year. Herr Berberich calculates (*Astronomische Nachrichten*, No. 3260) that it will then be somewhat brighter than at the return when it was discovered in 1884, and that its perihelion passage will probably take place on the 3rd of June. Its distance from the sun, when least, is nearly equal to that of Mars.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

61 CYGNI.

To the Editor of KNOWLEDGE.

SIR,—There are some points connected with these stars which I think astronomers have not sufficiently borne in mind. They must be physically connected. In one sense, of course, all stars are physically connected ; but in this case it seems certain that the two stars are at no great distance from each other, and that no other bright star is situate within a considerable distance of either. (There may be dark stars.) This is proved by their parallaxes. These have been so frequently determined, with but small difference in the results, that we can say with tolerable certainty that it lies between 0·4″ and 0·5″. And it appears to be almost the same for both stars. Consequently, one of them does not lie at any great distance beyond the other ; indeed, it is doubtful which is the more distant. But two stars with nearly equal parallaxes of (say) 0·4″, and an angular distance of (say) 20″, cannot be very remote—hardly as much so, I think, as some of our known periodical comets when at their greatest distances from the sun. And as these comets accompany the sun in its flight through space, so the pair 61 Cygni are evidently accompanying each other in a very rapid flight in which no neighbouring star partakes. Like the comets, they may move in very elongated ellipses or, possibly, even in hyperbolic orbits. But the motion can hardly be parabolic unless the combined mass of the stars is very small, for their relative motion is not considerable. For the same reason, a very elongated ellipse is unlikely. The apparent elongation is probably due, to a considerable extent, to projection.

Should Dr. Wilsing's results prove correct, we shall have one explanation of why a satisfactory orbit has not hitherto been computed. The distances vary periodically from some cause independent of the orbital motion which we are trying to compute, and the law of description of equal areas in equal times is probably not fulfilled. If one of the pair has a dark satellite, it is the centre of gravity of the star and satellite which describes equal areas in equal times round the other star, and otherwise fulfils the condition of the orbit. But, apparently, Wilsing found nothing but this oscillation in the distance. The mean distance seemed to have remained constant during his observations. If so, the orbital motion of the pair may be regarded as almost certain. Their distance has undoubtedly been increasing, and if the motion were rectilinear it would continue to increase. If the increase has been arrested the motion is orbital, and the distance is about to commence diminishing. A few years will tell.

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The motion at present is probably so slow that its exact nature can hardly be determined—it is, in fact, in the transition stage.

The pair should be closely watched, and the measures of different observers compared. The motion may not only prove to be orbital, but the period may be much less than is commonly imagined. Truly yours,

W. H. S. MONCK.

To the Editor of KNOWLEDGE.

DEAR SIR,—In the recent issue of the *British Astronomical Association Journal*, Vol. V., No. 1, the section of Astronomical Progress concludes an article on β Lyræ with the following thesis :—"A black stripe, then, overlaying a vivid ray in the spectrum of β Lyræ or elsewhere, can only be interpreted as a reversal. It demonstrates physical changes in the atmosphere of a single star."

This is obviously a conclusion of the first importance in stellar spectroscopic interpretations ; and it is necessary to examine the connection between it and its premisses. For these the reader is referred to an article by Miss A. M. Clerke in the June number of KNOWLEDGE, page 130, and briefly the argument is contained in the following propositions :—1. A combined spectrum from two close stars (unaffected by the displacements of relative radial motion) " is the simple summation of the rays." (" Not an algebraical summation. There are no negative qualities. The darkest ray cannot sink below the zero level of light.") 2. Therefore " vivid rays lose none of their light by subtraction. 3. Therefore " dark lines can never be seen projected upon bright ones emitted by a companion luminary."

In this argument the first proposition and its consequent, the second, are undeniable ; but the third proposition, or second consequent, goes too far, and does not militate against an imitation of a double reversal by the superposition of two spectra, one of which gives the hydrogen lines broad and bright, the other narrow and dark. In this case the narrow dark line will be seen dividing the broad bright line, not by *subtraction* of the bright line's intensity, but by less *addition* to it. The added quantities here are the intensities of the continuous spectrum of the dark line star on the two sides of the dark line ; so that the sum of light, on either side of it, is greater than at the position of the dark line.

It is true that this effect of superposition is attended with diminished contrast both between the bright line and its dark division, and between the bright line and the combined continuous spectrum ; but not necessarily to the exclusion of either.

Stonyhurst Observatory. WALTER SIDGREAVES.

MECHANICAL FLIGHT.

To the Editor of KNOWLEDGE.

SIR,—Referring to the December number of KNOWLEDGE, Mr. Moy says :—" The two greatest obstacles in the way of the accomplishment of mechanical flight have been the balloon and the screw propeller." Mr. Moy evidently does not believe in the screw ; he rather ridicules " Mr. Maxim and Lord Kelvin " for believing in this kind of a propeller.

Before commencing my experiments in aeronautics, I consulted one of the old members of the Aeronautical Society in regard to the efficiency of screw propellers, and he assured me that he himself had made a great many experiments and had witnessed many that had been made by others, including those of Mr. Moy, and in all cases it had been found that a screw propeller drew in air at the centre and discharged it at the periphery, and that there was a great deal of power wasted in this " fan-blower " action—in fact, so much that the screw propeller was absolutely of no value for aerial navigation. I then went to France, and saw the apparatus which the French Government used for testing the efficiency of screw propellers working in air. It was very beautifully constructed, and enabled one to measure the power required for driving the screw and also to determine with a great degree of nicety the thrust of the screw. But there were no means provided for allowing the screw to travel through the air, and to ascertain the thrust while it was travelling. Moreover, the screw propellers themselves—and there were a dozen of them—were so badly made as to render the experiments of no value.

In regard to the early experiments in England with screw propellers, I would say that a few semi-scientific gentlemen, without any special engineering training and with only a limited amount of money at their disposal, have conducted a few experiments on a small scale. These gentlemen have generally made their screws by loosely covering some badly-formed and rickety wooden or wire frames with a cotton or silk fabric. They have applied an unknown quantity of power, having no means of ascertaining the amount consumed or the thrust of the screw. Their experiments have been made while the screw was rotating in the same place, and not while it was advancing into new air, the inertia of which had not been disturbed. As might be expected, the results have been anything but satisfactory ; nevertheless, these gentlemen have constructed certain formulæ which they insist should be implicitly accepted by those who have more recently conducted experiments on a very much larger scale and with very much better apparatus.

In my early experiments with screw propellers, I provided myself with an apparatus, constructed in such a manner that it would enable me to ascertain with a great degree of nicety the exact power consumed in driving my propellers, not only while stationary but also while advancing at a high velocity into new air. It also enabled me to accurately measure the screw thrust under all conditions. In one of my first experiments with a well-made screw I found, if I multiplied the pitch of the screw in feet by the number of turns in a minute, by the thrust in pounds, and divided the product by thirty-three thousand, that it exactly corresponded with the readings of my dynamometer. This *indicated* that there was no skin friction. I then made a pair of blades without any twist or angle, and exactly the same thickness and area as the screw blades, and upon rotating these in the air at the same velocity I found, notwithstanding that my dynamometer was exceedingly sensitive, that the power required was so small as not to move the pointer. This *proved* that the skin friction was so small a factor as not to be considered. Upon trying the same experiments with a screw made exactly like those I had seen in France, I found, when its efficiency was computed on exactly the same basis, that it did not foot up to more than one-third the readings of the dynamometer, and I presume that this screw was quite as efficient as any that have ever been made or experimented with by Mr. Moy or his colleagues, and which have formed the basis of their dogmatic assertions.

In regard to the wasteful effects of the " fan-blower " action before referred to, I found, with a well-made screw, that the air instead of being drawn in at the centre and discharged at the periphery, as these gentlemen had supposed, was in reality—when not advancing into new

air—drawn in at the periphery and discharged in a straight line almost parallel to the axis.

In my large machine I employ two screws, each seventeen feet ten inches in diameter, and with a pitch of sixteen feet. Each screw has two blades and the projected area of all the blades is ninety-four square feet. When the machine is run over the track at the rate of forty miles an hour, the slip of the screws is eighteen miles an hour. If we consider the thrust of the screws on the Moy theory, which is fully explained and elaborated in your last issue, we should find that with eighteen miles slip the thrust would be 152·28 lbs. according to the formula $V^2 \times \cdot 005 \times A = P$ (V being the velocity in miles per hour, A the area in square feet, and P the pressure in pounds). This is computed on the basis that the thrust of the screw is equal to the projected area of the screw driven through the air at the velocity of the slip. Therefore, according to Mr. Moy's theory, it would be $18^2 \times \cdot 005 \times 94 = 152 \cdot 28$ lbs. I find that a great many others besides Mr. Moy compute the thrust of the screws on this same basis; others, however, believe that the whole screw disc, which in my case is five hundred square feet, should be considered. This would give $18^2 \times \cdot 005 \times 500 = 810$ lbs. screw thrust. However, the *actual* thrust was found to be rather more than two thousand pounds, or 13·1 times as much as Mr. Moy supposes.

Lord Kelvin, upon learning that I obtained a screw thrust of over two thousand pounds, came to Baldwyn's Park with some of his scientific friends and witnessed a number of my experiments. Without the least trouble I was able to run the engines fast enough to get this enormous amount of screw thrust. Upon witnessing this, Lord Kelvin frankly said that everything relating to aerial flight was many times more favourable than had been supposed, and that all the formulæ would have to be revised. This practical demonstration, however, is only looked upon by Mr. Moy as a "big joke." Evidently the larger the screw thrust, the bigger the joke.

Mr. Moy says, in his article in the December number of KNOWLEDGE, that my machine, like Henson's, has failed because "it slid backwards and injured its tail." In reply to this I would say that I know nothing about Henson's machine, except what I have heard. I believe, however, that he made a design of a very large machine, and then conducted a few experiments with a very small and imperfectly made apparatus, and that the power of the engines and the thrust of the screw were so small that if the machine had been dropped from a height, its weight acting upon the angle of the planes would have driven the screw backwards, instead of the screws driving the machine forwards; that is, the screw thrust under the most favourable circumstances, both in his large design and in his small machine, was so small that it would not balance the backward action of the machine caused by its weight acting through the angle of its planes.

With my machine, however, the planes are placed at an angle of one in eight, and the screw thrust is two thousand pounds. As my machine weighs eight thousand pounds, it will be seen that the backward action due to the angle of the plane would be considerably less than the screw thrust; consequently, my machine has no tendency to move backwards, but, on the contrary, *does* move forward at a high velocity, and it has never as yet run backwards and broken its tail. But it appears that facts have no influence on Mr. Moy's mind; if the facts do not correspond to his way of thinking, "bad luck to the facts then." Unlike Mr. Moy, I do not regard my experiments as a dead failure, as I have succeeded in making a machine which has a lifting effect greater than its total weight.

Mr. Moy concludes by suggesting that I should go to Salisbury Plain and propel my machine with a rope, instead of with screw propellers. The machine which depends upon a rope, and is secured to the earth by a rope, would in no sense be a flying machine; moreover, at the present time I am able to obtain a screw thrust of over two thousand pounds, and I find this quite sufficient to propel my machine through the air; in fact, if I cannot make a machine which will fly with a screw thrust of two thousand pounds, I think I had better abandon the whole thing. In my early experiments with a small apparatus I succeeded in lifting as much as fourteen times my screw thrust, but this was only computing the power actually required for driving the plane through the air. At the time of planning my large machine I expected to be able to obtain a screw thrust of fifteen hundred pounds, and to carry as much as ten times the screw thrust. When, however, my machine was completed, I found that I could obtain a screw thrust of over two thousand one hundred pounds, but that I was unable to lift ten times the thrust, on account of the great number of tubes and wires which were necessary to hold the engines and the aeroplanes in position, and to give the necessary rigidity to the structure. The machine in its present condition lifts rather more than five times the screw thrust, but I am of the opinion that if I should rebuild it I should be able to lift at least ten times the screw thrust.

I receive many letters with suggestions similar to those so kindly given me by Mr. Moy. I have not the least objection that Mr. Moy, and the rest of my numerous voluntary advisers, should go to Salisbury Plain, or in fact anywhere else, and spend the remainder of their lives propelling their machines with ropes, but as far as I am concerned I have found the screw a very efficient propeller—in fact, the ideal propeller for aerial navigation, because it enables me to apply a very large amount of power in a continuous manner without the agency of any complicated lever motions, and I am able to obtain a screw thrust which is quite sufficient to cause a well-made flying machine to mount in the air. HIRAM S. MAXIM.

Notices of Books.

THE BORDER-LAND BETWEEN VERTEBRATES AND INVERTEBRATES.

Amphioxus and the Ancestry of the Vertebrates. By A. Willey. (Macmillan, 1894, 8vo., pp. 316, illustrated.) Unfortunately, we have at the present day but few living animals which can in any sense be regarded as connecting links between any of the great primary groups into which the animal kingdom is divided; and, accordingly, when we do find such a link, or anything approaching thereto, the interest it excites is all the greater. One of these links, or half-links, exists in the form of the curious little animal commonly known as the lancelet, which, together with the ascidians and those remarkable worm-like creatures respectively termed *Balanoglossus* and *Cephalodiscus*, is now regarded as constituting a primary group—the Protochordata—ranking in our scheme of classification as equal to the Vertebrata.

First described by the German naturalist Pallas in 1778, from a specimen captured on the Cornish coast, the lancelet was referred to that refuge for the destitute—the Mollusca—where it remained till 1834, when it was rediscovered by Costa, on the Neapolitan coast, who gave it the name of *Branchiostoma*, and placed it among the fishes, in the neighbourhood of the lampreys and hags. It was again discovered by Yarrell in 1836, who assigned

the name of Amphioxus, and was the first to recognize the existence of a cartilaginous vertebral column, or notochord. The muscles of the body are divided into a number of septa, and a ring of tentacles surrounds the margins of the mouth, while the notochord is overlain by the nerve-tube. The extension of the notochord beyond the anterior extremity of the latter is a very exceptional condition, and has suggested the name of Cephalocorda for the ordinal group of which the lancelet is the sole representative. The atrium, or atrial chamber, is a cavity surrounding most of the internal organs, and opening by a relatively large aperture in the middle line of the body. The absence of paired fins in the lancelet is an important feature, as is the presence of a dorsal fin running the whole length of the back, curving forwards in front to join the ring of tentacles round the mouth, and expanded posteriorly into a caudal fin.

As regards the habits of this extraordinary creature, the author writes that "in consequence of the extension of the firm, and at the same time elastic, notochord to the tip of the snout, *Amphioxus* possesses an extraordinary capacity for burrowing in the sand of the sea-shore or sea-bottom. If an individual be dropped from the hand on to a mound of wet sand which has just been dredged out of the water, it will burrow its way to the lowest depth of the sand-hillock in the twinkling of an eye. Its usual *modus vivendi* is to bury the whole of its body in the sand, leaving only the mouth with the expanded buccal cirrhi (tentacles) protruding. When obtained in this position in a glass jar, a constant inflowing current of water, in which food-particles are involved, can be observed in the neighbourhood of the upstanding mouths. The food consists almost entirely of microscopic plants (diatoms, desmids, &c.) and vegetable *débris*. While passing through the pharynx, the food becomes involved in the slimy secretion of a gland at the base of the pharynx, and is thus held in the pharynx while the water with which it entered flows out through the gill-slits into the atrial chamber. The food is then carried through the intestine enveloped in a continuous cord of slime or mucus, which is kept in perpetual motion by the action of the cilia with which the epithelium of the alimentary canal is richly provided. Occasionally it emerges from its favourite position in the sand, and after swimming about for some time it will sink to the bottom, and then recline for a longer or shorter period upon its side on the surface of the sand. When resting on the sand it is unable to maintain its equilibrium in the same position, as an ordinary fish would do, but topples over on its side, indifferently to the right or left." This incapacity is due to the absence of the semicircular canals of the ear, which regulate the equilibrium in fishes. It may be further observed that the lancelet is a completely passive feeder, doing nothing in the way of biting, or even sucking, but merely taking what may happen to enter its mouth with the inflowing current of water.

As regards its distribution, the author observes that, speaking generally, "the lancelet is an inhabitant of shallow water; it is essentially a littoral form, and is apt to occur in the neighbourhood of any sandy shore. Its occurrence, however, is often curiously local, as shown by its behaviour at Messina. . . . In the Gulf of Naples it is extremely abundant; while in Plymouth Sound, in the English Channel, it is comparatively rare. On the coast of France it is said to grow to an unusually large size. It has been taken in greater or less numbers from many other localities in Europe, on the Atlantic and Pacific shores of North and South America, and from the shores of Australia, Japan, and Ceylon. Its geographical distribution may, therefore, be said to be pre-eminently world-wide, and, in fact, it is liable to turn up on any shore in the temperate and tropical regions."

In spite of this wide geographical distribution, all the lancelets, of which there are some nine species, are remarkably like one another, and form but a single genus. Whether this similarity is evidence of the archaic nature of these creatures (as the author considers to be the case) may be doubtful; but that the lancelets are an extremely ancient type may be considered certain. That the lancelet is not a fish is indisputable; and the two main questions connected with it and the other members of the Protochordata are: firstly, whether they are more closely connected with the vertebrates or the invertebrates; and, secondly, whether they are simple or degraded types.

As regards the first question, the fact that both lancelets, ascidians, *Balanoglossus*, and *Cephalodiscus* show the essentially vertebrate character of a dorsally-situated nervous system, a notochord, and gill-slits, indicates clearly that all are nearer to the vertebrates than to the invertebrates, and consequently, that they cannot be regarded as direct connecting links between the two. Nevertheless, there are not wanting some signs of connection between the chordate and non-chordate types; the peculiar larva (*Tornaria*) of *Balanoglossus* having marked resemblances to the larvæ of the echinoderms; while in the nemertine worms the proboscis exhibits certain structural approximations to that of *Balanoglossus*, which contains the notochord. And here it may be remarked, as a very curious circumstance that, while in the latter the notochord persists in the anteriorly placed proboscis, in the larvæ of the ascidians it remains in the tail.

On the subject of the degeneration, or otherwise, of the existing Protochordates, the author (probably wisely) does not pronounce any very decided opinion; but the feature last mentioned seems to indicate pretty clearly that, while we may look upon these creatures to a certain extent as retaining simple archaic features, yet that degeneration has played no inconsiderable part in producing their present structure. All that the author can suggest as to the proximate ancestor of the vertebrates is, that it was probably a free-swimming marine animal intermediate in organization between the larva of an ascidian and the lancelet.

In a work so admirably thought out and executed as is the one before us, there is but little room for criticism; and we, therefore, need only conclude by saying that "Amphioxus and the Ancestry of the Vertebrates" will long remain the single authority on a most interesting and at the same time a most difficult subject. While full of technical details, it is so clearly expressed as to be readable by all acquainted with the rudiments of zoology.—R. L.

BOOKS RECEIVED.

Ethics of Literature. By John A. Kersey. (E. L. Goldthwait & Co., Marion, Ind.)

Cloudland; A Study of the Structure and Character of Clouds. By Rev. W. Clement Ley, M.A., F.R.Met.Soc., with numerous coloured plates, photographs, charts and diagrams. (Edward Stanford, Charing Cross, S.W.) 7s. 6d. net.

Meteorology, Practical and Applied. By J. W. Moore, B.A., M.D., F.R.C.P.I. (F. J. Rebman.) 8s.

Allen's Naturalist's Library: Monkeys, Vols. 1 and 2. By Henry O. Forbes, LL.D. 6s. each. Also Butterflies, Vol. 1. By W. F. Kirby. (W. H. Allen & Co.) 6s.

Elements of Astronomy, with numerous examples and examination papers. By George W. Parker, M.A. (Longmans, Green & Co.) 5s. net.

The Coal Question and the true value of the Fuel Economizer. By James G. Calvert. (6, St. Mary's Gate, Manchester.)

Climbing in the Himalayas, with Maps and Scientific Reports. By William Martin Conway, M.A., F.S.A., F.R.G.S. (T. Fisher Unwin.) 5s. net.

The Planet Earth: An Astronomical Introduction to Geography. By Richard A. Gregory. (Macmillan & Co.) 2s.

The Thumb Ready Reckoner. (Henry Frowde.)

The Liberty Review Yearly for 1895. (The "Liberty Review" Publishing Co.)

Cassell's Family Magazine for December. (Cassell & Co.)

Science Gossip for December. (Simpkin, Marshall & Co.)

Journal of the Photographic Society of India for November. (Thacker, Spink & Co., Calcutta.)

Cassier's Magazine for December.

Science for All; Part 59. (Cassell & Co.) 7d.

The Journal and Transactions of the Royal Photographic Society of Great Britain, for Nov. 29th. (W. Watson & Sons.) 1s.

The Zoophilist for December. (Society for the Protection of Animals from Vivisection, 20, Victoria Street.) Post free 3½d.

Illustrated Modern Art and Literature—Christmas Number.

The Monist for October (Quarterly). (Watts & Co.)

Current Literature for December. (52, Lafayette Place, New York.) 25 cents.

Yuletide—Christmas Number. (Cassell & Co.)

Science Siftings for December 15th.

Sunshine for January.

Publications of the Lick Observatory, Vol. III., 1894. (Illustrated.)

Le Monde Moderne. Revue Mensuelle Illustrée. Janvier, 1895.

J. H. Steward's (Electric Light Lanterns, &c.) *Supplemental List* for 1894-95. (J. H. Steward, 406, Strand.)

Science Notes.

At the meeting of the Royal Society on November 30th 1894, the anniversary address was delivered by the President, Lord Kelvin. He dwelt more especially on the labours of Helmholtz, of the whole of whose great and splendid work in physiology, physics, and mathematics, he doubted whether any one man was qualified to speak with the power which knowledge and understanding can give. All, however, could appreciate to some degree the vast services which Helmholtz had rendered to biology, by the application of his mathematical genius and highly-trained capacity for experimental research to physiological investigation. In his researches on fermentation and putrefaction, Helmholtz showed that they were not purely chemical processes of slow combustion produced by oxygen, as was hitherto supposed, but that they were almost certainly due to the actual presence of a living creature—bacterium as it is now called. This early work constituted a very long step towards the great generalization of Pasteur, adverse to spontaneous generation, and decisive in attributing to living creatures, born from previous living creatures, not only fermentation and putrefaction, but a vast array of the virulent diseases and blights which had been most destructive to men and the lower animals, and crops and fruits. After welcoming the establishment of the Faraday-Davy Research Laboratory, Lord Kelvin went on to mention what was, to his mind, undoubtedly the greatest scientific event of the past year, the discovery of a new constituent of our atmosphere. Lord Rayleigh, in the course of a long research commenced in 1882, in order to obtain a redetermination of the densities of the principal gases, attacked nitrogen resolutely, and stimulated by most disturbing and unexpected difficulties in the way of obtaining concordant results for the density of this gas, as obtained from different sources, discovered that the gas obtained by taking vapour of water, carbonic acid, and oxygen from common air was denser by $\frac{1}{230}$ than nitrogen obtained by chemical processes from nitric oxide, or from nitrous oxide, or from ammonium nitrite, thereby rendering it probable that the nitrogen in atmospheric air is a mixture of nitrogen and a small proportion of some unknown and heavier gas. Rayleigh, working with Ramsay, has since succeeded in isolating the new gas, both by removing nitrogen from common air by Cavendish's old process of passing electric sparks through it, and taking away the nitrous compounds thus produced by alkaline liquor, and by absorption by metallic magnesium. Thus there is given a fresh and most interesting verification of a statement made by Lord Kelvin in his presidential address to the British Association in 1871:—"Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new; but nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient, long-continued labour in the minute sifting of numerical results." Investigation of the new gas has led to the wonderful conclusion that it does not combine with any other chemical substance hitherto presented to it; and it is hoped that much more will be known, before the next anniversary meeting of the Royal Society, as to the properties of the hitherto unknown and still anonymous fifth constituent of our atmosphere.

The 1893 report of the Scotch Fishery Board (Part 3, Scientific Investigation) is before us. It reveals a wide field still undeveloped for profitable scientific research, at the head of which should have been placed a man of recognized experience and ability. We cordially agree that "the choice of the kind of individual should not be left to Government."

THE IVY: ITS STRUCTURE AND GROWTH.

By the Rev. ALEX. S. WILSON, M.A., B.Sc.

ALTHOUGH the associations connected with the ivy in most persons' minds are poetical or historical rather than scientific, this familiar plant is singularly interesting because of the number of noteworthy botanical characters it presents. Among other peculiarities, the ivy blooms in winter. Its flowers are produced in November and December, and some of our readers may not have had many opportunities of seeing them. They are formed in little clusters or umbels of ten or twenty with the flower-stalks radiating from the top of the shoot, as indicated in the accompanying sketch. This type of inflorescence is characteristic of and gives its name

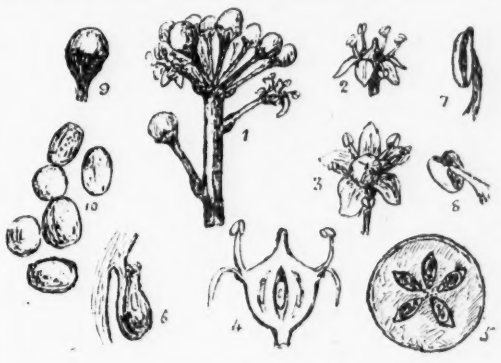


FIG. 1.—Flower of Ivy (*Hedera helix*).

1, Umbel; 2 and 3, separate flowers; 4, vertical section, showing epigynous insertion; 5, transverse section of ovary; 6, anatropal ovule; 7 and 8, stamen; 9, bud, showing minute sepals; 10, pollen grains, highly magnified.

to the *Umbelliferæ* or hemlock order, to which the ivy family, *Araliaceæ*, is closely related. The umbel of the ivy is simple; those of the hemlock family are mostly

compound, each ray of the primary umbel terminating not in a single flower, but in a smaller umbel. A curious feature is the almost constant occurrence in the ivy of a single isolated flower springing from a point considerably lower than the umbel. On the specimen drawn (Fig. I., 1), there were two of these detached flowers; their presence may be accounted for on the supposition that the umbel is derived from the raceme. The latter is a more elongated inflorescence, in which the individual flowers are separated by joints or internodes of the main stem. These isolated flowers of the ivy are possibly relics of this earlier condition; at the same time it is quite likely that some advantage arises to the plant from the retention of this ancestral character.

Each little flower has five green petals, which become deflexed soon after expanding; they are of short duration and fall off after a few days. Alternating with the petals are five free stamens; the anthers open by a longitudinal chink through which the pollen is discharged, and they are attached to their stalks in the manner shown. (Fig. I., 7 and 8.) Both stamens and petals are inserted on the top of the ovary, a position which is described as epigynous, the ovary being inferior. These characters at once fix the systematic portion of the ivy in the Calycifloral division of polypetalous Dicotyledons, in which are included, among others, the orders *Rosaceæ*, *Leguminosæ*, and *Umbelliferæ*. From the last mentioned the ivy is at once distinguished by its five, sometimes four-celled, ovary; the fruit of *Umbelliferæ* being invariably two-celled. Attached to the inner angle of each of the five cells is a single pendulous seed or ovule, so reflexed that its stalk adheres to one side, forming a ridge or raphe. This inverted or anatropal condition is very usual, and has the advantage of bringing the opening or micropyle close to the placenta to meet the descending pollen-tube, which travels along the placenta. Ivy pollen has the adhesive character common in entomophilous flowers; the grains are broadly elliptical and remind one of the pollen of the rock-rose. The style is short, and its extremity forms the stigma; there is no knob-like expansion, as so often is the case. The top of the ovary offers, as it does also in the poppy, a convenient stage on which visitors can alight. Nectar, in the form of numerous minute drops, is secreted by the spongy tissue on the lid of the ovary. The yellow colour of this secreting surface adds to the conspicuousness of the flowers; what attractiveness they possess is, however, mainly due not to the petals but to the bright yellow anthers, and to the flowers growing together in a crowded inflorescence.

Notwithstanding its season of flowering, the ivy is evidently adapted for insect fertilization. The pollen and stigma are not those of an anemophilous blossom. Winter flowers are often self-fertilizing, but the exposed honey of the ivy accessible to short-lipped insects indicates, as Delpino first remarked, adaptation to the visits of flies. Müller mentions having seen the ivy visited by wasps. The stamens ripen before the stigma, rendering self-fertilization unlikely, while the position of the parts is also calculated to prevent it. On a rocky piece of shore where the ivy grows in great profusion I recently had an opportunity of observing its flowers in perfection, and in none of those examined had any of the pollen fallen on the stigmas. I was greatly interested, however, to notice how frequently the flowers were visited by blue-bottle flies. These insects were the only ones, with the exception of gnats, which could be seen in the neighbourhood of the ivy during my visits. From their numbers, and from seeing them constantly at work in the blossoms, I was firmly convinced that the ivy is mainly indebted to the blue-bottle for the fertilization of its flowers. No one would dream of any connection between ivy and blue-bottles; the combination savours not a little of the grotesque.

Ivy flowers have a faint though distinct odour, which, if not disagreeable, partakes of the fœtid or ammoniacal character not uncommon in blossoms adapted to Diptera. Blue-bottles, according to Müller, fertilize the carrion-flowers of Stapelia, and these flies, as Dr. J. E. Taylor mentions in his interesting work, are often so completely deceived by the putrid odour that they make the mistake of laying their eggs on the petals of Stapelias in greenhouses. The ivy blossoms, in respect of these visitors, might therefore almost be ranked as carrion-flowers.

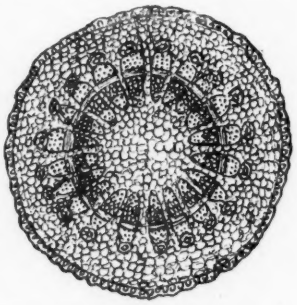
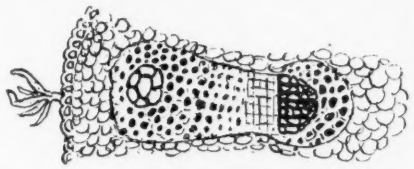


FIG. II.—Transverse Section of Young Ivy Stem.

One might easily overlook the five minute teeth between the petals, which are all the ivy possesses in the way of sepals. A better example of rudimentary and functionless organs could hardly be named. Such vestiges or heirlooms are held to prove the descent of the ivy from ancestors possessing both a calyx and a corolla. Sepals are protective organs; the entire inflorescence of the *Umbelliferæ* is protected by the bracts, and the sepals, not being required, are aborted, as in the ivy. The bracts at the base of the ivy umbel are so small that they are useless as organs of protection, and this office is therefore discharged by the corolla. The sepals of the anemone, marsh marigold and other flowers are brightly coloured and assume the office of attraction, which properly pertains to the corolla; it is much more unusual to find petals, as in the ivy, doing protective duty like sepals. Not only are they of very little service in the way of attracting visitors, but their valvate arrangement in the bud is a further approximation to the sepaline character.

Green, though the normal colour of foliage leaves, is not very common among petals. As all parts of a flower are modified leaves, it might readily be supposed that a green corolla results from arrested development, and represents the early or primitive condition of flowers; but it is much more in accordance with our knowledge of flowers to regard green petals as evidence of degeneration. Under cultivation, as is well known, the numerous stamens of the wild rose become transformed into the petals of the garden variety. The frequency of such a change renders it probable that petals were originally derived, not immediately from leaves, but from stamens. If, as some suppose, all flowers at first consisted of essential organs alone, and if in those which were much visited by insects the corolla arose from an outer row of stamens becoming sterilized and petaloid for the purpose of attracting visitors, then, as stamens are mostly yellow, the probability is that the first petals would be yellow also. In the water-lily, again, not only do the stamens gradually pass into petals, but the latter shade off into green sepals which must, therefore, represent a later phase in the metamorphosis of a stamen than a petal does. If the floral envelopes have originated from stamens, as their condition in the water-lily would lead us to believe, the green colour even of sepals cannot be primitive, and much less can green be the primitive colour of the corolla. Though somewhat speculative, this theory of the origin of the corolla, which will be found elaborated in Grant Allen's essay on the colours of flowers, has still sufficient warrant to prevent

our assuming that green petals necessarily represent an early stage in the evolution of the corolla. As regards the ivy at least, there is little room for uncertainty; the inferior ovary and united carpels are certain marks of advanced organization. The closest relationships of the ivy order are with flowers having united petals, especially with the *Caprifoliaceæ*, which includes the honeysuckle, elder, snowberry, guelder-rose, and laurustinus, and such relationship is also indicative of a high degree of development. The aborted sepals, again, afford clear evidence of degradation, and when all other parts of the flower show signs of extensive modification it is highly improbable that the petals alone should have retained their primitive character. The inflorescence, the floral envelopes, and the natural affinities of the plant point unquestionably to ancestors possessed of blossoms more gaily attired than those with which the ivy is now adorned.



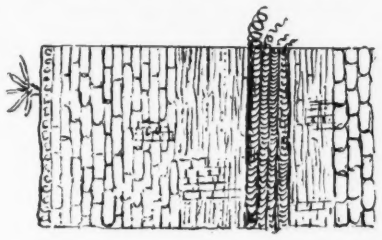


FIG. III.—Transverse Section of Fibro-vascular Bundle.

FIG. IV.—Vertical Section of Fibro-vascular Bundle.

The ovary as it matures develops into a black berry, which ripens in February. Ivy berries are said to possess emetic properties. Baccate fruits of this description, as explained in a previous article, have their seeds dispersed through the agency of birds, which are attracted by the colour and sweetness of the fruits.

The leaf arrangement of the ivy is alternate or spiral, and each leaf is supported on a long foot-stalk. In size and shape the leaves vary very much; the three-lobed form is frequent, but perhaps the five-lobed or palmatifid is the typical form. This shape is thought by Sir John Lubbock to possess the advantage of bringing the centre of gravity near the point of support. There is a remarkable difference in the ivy between the leaves of the flowering shoots and those which only bear foliage. The former are narrow and lanceolate, while the latter are broad and lobed. The breadth of a leaf would appear to be determined to some extent by the distance between the successive leaves, and the ivy affords an example of the rule; for the internodes of the flowering shoot are generally much shorter than those of the leaf-bearing branches. The upper surface of the leaf is glossy—a provision, in Lubbock's opinion, to prevent snow accumulating on the plant and breaking it down by its weight, as frequently occurs with the branches of trees. Such a provision is, of course, only needed by evergreens like the ivy which do not shed their leaves in the autumn. The duration of the leaves of evergreens varies: on the ivy, holly, and cherry-laurel they remain through the winter, and only fall off when the new ones are developed in the spring; those of the araucaria, on the other hand, persist for several years. The brown marbling often seen on ivy leaves is due to the presence of a red-coloured sap in some of the cells. Variegation occasionally arises, as in other plants, from the absence or deficiency in certain parts of chlorophyll, as the green colouring matter of plants is called. For this vegetable albinoism it is difficult to assign a cause, though we have seen ivy with the dodder growing on it, in which the variegation appeared to be the direct result of the action of the parasite. The ivy appears, however, to be as a rule a remarkably healthy plant, injurious insects and parasitic fungi rarely injuring it.

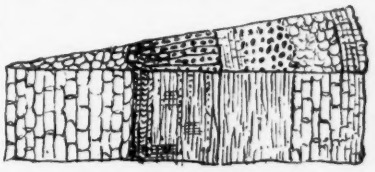


FIG. V.—Sections of Older Stem.

The climbing habit of this plant gives it considerable advantage over other species which have to form an erect self-supporting stem. A climber can get its leaves exposed to the light more rapidly and with less expenditure of material than a plant which does not climb. Climbing species are very numerous, especially in tropical forests, where almost every tree may be festooned with rope-like twiners. In such situations the struggle for light is intense; slow-growing plants, getting overtopped by those of rapid growth, perish, while climbers enjoy every advantage. The latter attain their object in a variety of ways; the hop and convolvulus by means of a spontaneously revolving stem, the passion flower by sensitive curling tendrils, Clematis and Tropæolum by means of their twisted leaf-stalks, and the bedstraw by the help of its epidermal hooklets. In the ivy and creeping fig, the climbing is effected by means of adventitious roots emitted from various parts of the stem and branches. That these are really roots is shown by their deep-seated origin and by the root-collar they form at the point where they burst through the cortical layers of the stem. These roots are, however, merely organs of support, and do not injure the tree on which they grow, as the roots of a parasite like the mistletoe do by absorbing its sap. The ivy is not, therefore, a parasite but simply an occasional epiphyte, which depends on other plants for mechanical support only. Besides climbers, many tropical orchids are also epiphytic in their habits. A peculiarity of the ivy stem which greatly assists it in climbing is its negative heliotropism. The stems of most plants bend towards the light, but the ivy stem is exceptional, its tendency being to bend away from light. The effect of this tendency is to press the young branches very close against any supporting wall or tree, so that the little roots are able to adhere firmly, and their outer cells being converted into a kind of mucilaginous cement, the ivy is thus glued to its support.

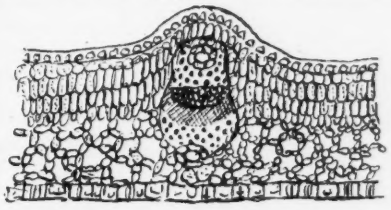


FIG. VI.—Transverse Section of Leaf.

On the flower-stalk the surface is slightly furred. The microscope shows this to be due to curious stellate hairs which have an odd resemblance to a starfish. Hairs on the stalks of flowers, as Kerner has taught us, serve to exclude creeping insects, only winged visitors being of use for cross-fertilization. Possibly, these star-shaped hairs serve this purpose in the ivy, but in any case they illustrate the transition from hairs to scales, the latter being merely flattened hairs.

XUM

The ivy is a very convenient plant for microscopical study. With a wet razor one can easily make transverse and longitudinal sections which show admirably the principal features in the histology of dicotyledons. The cross section of the stem forms a beautiful microscopic object. Fig. II. shows a ring of twenty fibro-vascular bundles, in the centre of which are seen the large thin-walled cells of the pith. The space between the vascular ring and the epidermis is filled with cortical parenchyma, also consisting of thin-walled cells. Connecting this latter with the pith are plates of cellular tissue, which pass between the bundles and are called the medullary rays. In Fig. III. a single bundle is shown more highly magnified. In this we may note on the left the air canal; next this a quantity of bast composed of thick-walled or sclerenchymatous cells; inside of this is the soft bast, the inner portion of which is the cambium layer, where the cells are seen undergoing division. The wood of the bundle lies just inside the cambium; its cells are represented in a darker shade. Large spiral vessels are seen towards the inner part of the wood, and on the face of the bundle next the pith are more thick-walled sclerenchymatous cells. One of the stellate hairs is represented on the outside. Bundles similar to the above compose the veins of the leaf; while a section of the leaf shows that in the ivy the difference between the upper stratum of closely packed palisade cells and the lower one of laxer tissue is especially marked. The palisade cells, covered by the upper epidermis which is devoid of openings, constitute a tissue adapted to retain water, and the tissue of the lower half of the leaf is full of large intercellular passages; the cells, in fact, only form a kind of framework. These passages communicate with the external air through the stomata on the under side of the leaf. This lower stratum is, therefore, a tissue which has been specialized for the elimination of watery vapour. The epidermal cells of the leaf, as in a number of cases, present a wavy outline — bordered pits, not unlike those of the pine, occur in the cells of the wood; but a better idea of the anatomical structure will be obtained from the drawings than from any description in words.

Geographically the ivy is an outlier, being the only European representative of its family; the rest of the order are tropical or sub-tropical, a significant circumstance, going to show that the ivy has acquired its peculiar characteristics in adaptation to the more rigorous conditions of colder latitudes.

THE SCORPION'S STING.

By C. A. MITCHELL, B.A.Oxon.

AMONG invertebrate animals the scorpion occupies an invidious position very similar to that held by the serpent among the vertebrate. Each is regarded with fear and dislike, and to each a malignity has been attributed which it does not possess. The scorpion, perhaps, has suffered even more than the serpent from this exaggerated disgust; but although its fierceness may justify some of the epithets applied to it, it is but fair to take into account the fact that it only uses its weapon for the natural purposes of procuring food and defending itself when molested.

There are upwards of two hundred species of the scorpion known, but only about a dozen are found in Europe. The larger and more dangerous species all occur in tropical countries, and in India and Africa are sometimes fatal to human life. The three kinds which have been most studied are *Scorpio europæus*, which is common in caves in South Europe; *Scorpio occitanus*, also a European species; and *Scorpio afer*, the dreaded African scorpion.

The poison apparatus is situated in the last of the six joints of the tail. It consists of a bent, horny sting, having on each side of it a long opening communicating with the two glands secreting the poison. When running, the scorpion has its tail curved over its back, and on striking suddenly straightens it, thus bringing the sting downwards. At the moment when it is preparing to strike, a droplet of poison has been seen to exude from the duct, but more is forced out when the sting meets the resisting body. The amount of poison secreted, at any rate in the European varieties, is very small. Jusset estimated the quantity in a specimen of *S. occitanus*, two inches in length, at ·03 of a grain. This quantity, however, was sufficient to kill a fair-sized dog, and Paul Bert found that a scorpion of about the same size contained enough to rapidly destroy three frogs in succession.

From the difficulty of obtaining sufficient for the purpose, the chemical nature of the poison has been but little studied. In appearance it is a clear, limpid liquid, with a pungent smell and slightly acid reaction. It is soluble in water in all proportions, but is insoluble in alcohol and ether. Its density is a little greater than that of water. Under the microscope transparent epithelial fragments and fine granular matter may occasionally be noticed. The fact that it is coagulated by alcohol points to its being of an albuminoid * nature, and this would agree with Joyeux-Laffuie's suggestion that it is of analogous composition to snake venom, possibly containing some principle similar to the *echidnin* obtained by Prince Lucien Bonaparte from the venom of the viper. The fine granules referred to above are soluble in acetic acid and weak solutions of potash, but beyond this little is known of their properties or of what part they play in the action of the poison on the animal system.

The physiological effects of the venom as a whole have been frequently described since Maupertuis proved, in 1731, that though the sting of the common scorpion might prove fatal to a small quadruped, such a result was very rare. The general symptoms following a sting are (1) local inflammation, (2) convulsions caused by the action of the poison on the nerve centres, and (3) paralysis from its action on the extremities of the motor nerves.

Jusset stated, as the result of his experiments, that the venom acted directly on the red corpuscles of the blood, causing them to adhere together, thus obstructing the entrance to the capillaries, and stopping the circulation.

Other observers, however, do not confirm his conclusions. According to Paul Bert the blood is not affected. He found there was no alteration in the blood of the heart of frogs which had died from the effects of the sting, with the exception of one case where it appeared very dark at first but reddened on contact with the air. In no instance was its power of coagulating destroyed. He, therefore, considered the venom as a nerve poison only, which, like the South American poison *curare*, acted on the motor nerves while it left the sensibility untouched, but which, unlike *curare*, produced violent convulsions analogous to those produced by strychnine. Valentin† suggested the possibility of using *curare* as an antidote. When a little of this substance was introduced under the skin of frogs before being stung, the symptoms were greatly modified and electrical stimulus now produced no muscular contraction. The frogs recovered in two or three days, while others not thus treated perished from the effects of the sting.

As in the case of the bite of a venomous serpent, the

* See KNOWLEDGE, June, 1894. † *Zeit. für Biologie*, Bd. XII.

severity of the symptoms depends a good deal on the condition of the scorpion which inflicts the wound. Reid found that the venom of a small African species was speedily exhausted. He caused pigeons to be stung in rapid succession by the same scorpion. The first died almost immediately, the second recovered after some time, while the third was proof against a dozen stings. With the larger tropical varieties, some of which attain a size of nine or ten inches, he would probably have obtained very different results.

The venom appears to be without action when taken internally, since mice, which succumb rapidly when stung, will devour scorpions without being any the worse. This is another point of resemblance between it and snake poison.

Since the scorpion feeds on small insects, it is natural to find that on them the poison acts with great rapidity. A cricket stung in the leg became paralyzed almost immediately; spiders died in a few minutes; and a *thelyphonus*, a species closely allied to the scorpion tribe, though not venomous, succumbed in ten seconds.

It is possible that a scorpion may be able by means of its sting to destroy another less venomous species, but it is highly improbable that it should be able to do the same to one of its own kind, and there is no reliable evidence to prove that such is the case. If it were so, it would be a strong point in favour of those who have given accounts of having seen the scorpion commit suicide. It has often been asserted that when surrounded with a circle of glowing charcoal, the insect runs all round endeavouring to make its escape, and when unable to do so, deliberately stings itself to death. Maupertuis tried the experiment, but with a negative result. Later writers, however, are very positive on the point. Surgeon-General Bidie* describes how the rays of a burning-glass, concentrated on the back of the scorpion, caused it to use its sting and die immediately. Gillman† gives similar affirmative evidence. There appears, however, to be little doubt that these gentlemen misinterpreted what they observed, and that the scorpion must be acquitted of this one, at least, of the charges brought against it.

Prof. Bourne,‡ who examined experimentally the evidence on this question, came to the conclusion that although the scorpion, when exposed to heat, often appears to use its sting as a speedy method of ending its misery, in reality it does not do so. His experiments show that while it is physically capable of stinging itself, and though there can be no doubt that in its writhing the sting often does penetrate its back, yet there is no proof that the venom has any effect. He found that when he pierced the back of a scorpion with its own sting or with that of another insect, no ill effects followed; and as corroborative evidence he urges that when scorpions are fighting, though they frequently sting one another, they do their actual killing by pulling their opponents to pieces. In no instance did he see one insect perish from the sting of another, the only effect being to occasionally render it sluggish for a short time. The real explanation of the so-called suicide is that the scorpion is extremely sensitive to heat, and that some observers have attributed to the venom an effect which is due to the heat alone. When exposed to a temperature of over 50° C. the scorpion runs about, lashing itself with its tail, and in a few minutes becomes motionless. The same thing happened when one was placed in a dish exposed to the rays of an Indian sun, the insect becoming torpid in from seven to ten minutes. That the venom played no part in this result Bourne proved by experiments in which the sting was removed, or prevented from being used by being tied down, when the scorpion died as quickly as before.

These experiments appear so conclusive that the question may be looked upon as definitely settled once for all. And, as in many other cases, where poetry has borrowed similes from natural science, which later knowledge has shown to be false, these proofs of the insect's innocence of suicidal inclination take the point from Lord Byron's simile, and some other comparison must be found for a mind which "broods o'er guilty woes" than that of "the Scorpion girt by fire."

* *Nature*, Vol. XI. † *Nature*, Vol. XX.
‡ *Proc. Roy. Soc.*, 1887.

THE FACE OF THE SKY FOR JANUARY.

By HERBERT SADLER, F.R.A.S.

SOLAR spots and faculæ show a diminution both in number and size. Conveniently observable minima of Algol occur at 10h. 56m. P.M. on the 13th, 7h. 45m. P.M. on the 16th, and 4h. 34m. P.M. on the 19th. A maximum of the beautiful variable star o (Mira) Ceti occurs on the 14th. The magnitude at maximum is somewhat variable; in 1799 it was as bright as a first magnitude, while in 1868 it did not exceed a fifth magnitude star. The interval from first visibility to the naked eye to maximum is six weeks, and from maximum to invisibility to the naked eye about ten weeks.

Mercury is invisible during the greater part of January, being too near the Sun. On the 27th he sets at 5h. 40m. P.M., or about 1h. after the Sun, with a southern declination of 16° 35′, and an apparent diameter of $5\frac{1}{4}''$, $\frac{9}{10}$ths of the disc being illuminated. On the 31st he sets at 6h. 4m. P.M., or 1h. 18m. after the Sun, with a southern declination of 13° 54′, and an apparent diameter of $5\frac{1}{2}''$, $\frac{83}{100}$ths of the disc being illuminated. He is in superior conjunction with the Sun on the 10th. While visible he describes a direct path through a portion of Capricornus to the confines of Aquarius, being near the $5\frac{1}{2}$ magnitude star μ Capricorni on the 30th.

Venus is an evening star, but like Mercury, is too near the Sun to be observed till the end of the month. On the 21st she sets at 5h. 31m. P.M., or 1h. 3m. after the Sun, with a southern declination of 18° 6′, and an apparent diameter of 10·0″, $\frac{98}{100}$ths of the disc being illuminated. On the 31st she sets at 6h. 4m. P.M., with a southern declination of 14° 12′, and an apparent diameter of $10\frac{1}{4}''$, $\frac{97}{100}$ths of the disc being illuminated. While visible she is near Mercury, pursuing nearly the same path in the heavens.

Mars is an evening star, but is rapidly dwindling in apparent size and brightness. On the 1st he sets at 2h. 19m. A.M., southing at 7h. 8m. P.M., with a northern declination of 12° 40′, and an apparent diameter of $10\frac{3}{4}''$, the phase on the n f limb amounting to 1·1″. On the 11th he rises at 11h. 26m. P.M., with a northern declination of 14° 15′, and an apparent diameter of $9\frac{3}{4}''$, his brightness being about what it was at the beginning of June. On the 21st he rises at 10h. 55m. A.M., with a northern declination of 15° 52′, and an apparent diameter of $8\frac{3}{4}''$. On the 31st he rises at 10h. 26m. A.M., with a northern declination of 17° 29′, and an apparent diameter of 8″; the phase amounting to 0·9″. During January he describes a direct path in Aries.

Jupiter is an evening star, and is admirably situated for observation. He sets on the 1st at 7h. 34m. A.M., or 34m. before sunrise, with a northern declination of 23° 15′, and an apparent diameter of $46\frac{3}{4}''$. On the 12th he sets at 6h. 45m. A.M., with a northern declination of

23° 16′, and an apparent diameter of 46″. On the 22nd he sets at 6h. 1m. A.M., with a northern declination of 23° 17′, and an apparent diameter of 45½″. On the 31st he sets at 5h. 22m. A.M., or 2h. 21m. before sunrise, with a northern declination of 23° 18′, and an apparent diameter of 44½″. During the month he describes a short retrograde path from the confines of Gemini into Taurus, being exceedingly near the 5th magnitude star 1 Geminorum on the 5th. The following phenomena of the satellites occur while the Sun is more than 8° below and Jupiter 8° above the horizon:—On the 2nd an occultation reappearance of the first satellite at 5h. 39m. A.M.; a transit ingress of the second satellite at 8h. 4m. P.M., and of its shadow at 8h. 37m. P.M.; a transit egress of the satellite at 10h. 40m. P.M., and of its shadow at 11h. 14m. P.M. On the 3rd a transit ingress of the first satellite at 2h. 57m. A.M., of its shadow at 3h. 14m. A.M.; a transit egress of the satellite at 5h. 13m. A.M., and of its shadow at 5h. 30m. A.M. On the 4th an occultation disappearance of the first satellite at 5h. 5m. A.M.; a transit ingress of the third satellite at 1h. 57m. A.M.; an eclipse reappearance of the first satellite at 2h. 37m. 39s. A.M.; a transit ingress of the shadow of the third satellite at 3h. 11m. A.M., a transit egress of the satellite itself at 4h. 46m. A.M., and of its shadow at 6h. 3m. A.M.; an eclipse reappearance of the second satellite at 6h. 13m. 8s. P.M.; a transit ingress of the first satellite at 9h. 23m. P.M., and of its shadow at 9h. 43m. P.M.; a transit egress of the first satellite at 11h. 39m. P.M., and of its shadow at 11h. 59m. P.M. On the 5th an occultation disappearance of the first satellite at 6h. 31m. P.M., and its eclipse reappearance at 9h. 6m. 22s. P.M. On the 6th a transit egress of the first satellite at 6h. 5m. P.M., and of its shadow at 6h. 28m. P.M. On the 7th an eclipse reappearance of the third satellite at 7h. 46m. 49s. P.M. On the 8th an occultation disappearance of the second satellite at 4h. 8m. A.M. On the 9th a transit ingress of the shadow of the fourth satellite at 4h. 0m. 55s. A.M., its transit egress at 5h. 18m. A.M.; a transit ingress of the second satellite at 10h. 20m. P.M., of its shadow at 11h. 14m. P.M. On the 10th a transit egress of the second satellite at 0h. 57m. A.M., and of its shadow at 1h. 52m. A.M.; a transit ingress of the first satellite at 4h. 41m. A.M., and of its shadow at 5h. 9m. A.M. On the 11th an occultation disappearance of the first satellite at 1h. 50m. A.M., its eclipse reappearance at 4h. 32m. 44s. A.M.; a transit ingress of the third satellite at 5h. 15m. A.M.; an occultation disappearance of the second satellite at 5h. 15m. P.M., its eclipse reappearance at 8h. 48m. 38s. P.M.; a transit ingress of the first satellite at 11h. 7m. P.M., a transit ingress of its shadow at 11h. 37m. P.M. On the 12th a transit egress of the first satellite at 1h. 23m. A.M., and of its shadow at 1h. 54m. P.M.; an occultation disappearance of the first satellite at 8h. 16m. P.M., and its eclipse reappearance at 11h. 1m. 29s. P.M. On the 13th a transit ingress of the first satellite at 5h. 33m. P.M., and of its shadow at 6h. 33m. P.M.; a transit egress of the first satellite at 7h. 50m. P.M., and a transit egress of its shadow at 8h. 23m. P.M. On the 14th an eclipse reappearance of the first satellite at 5h. 30m. 19s. P.M.; an occultation disappearance of the third satellite at 6h. 43m. P.M., and its eclipse reappearance at 11h. 48m. 5s. P.M. On the 17th a transit ingress of the second satellite at 0h. 38m. A.M., and of its shadow at 1h. 51m. A.M.; a transit egress of the satellite at 3h. 15m. A.M., and of its shadow at 4h. 29m. A.M. On the 18th an occultation disappearance of the first satellite at 3h. 35m. A.M.; an occultation disappearance of the second satellite at 7h. 31m. P.M., and its eclipse reappearance at 11h. 23m. 58s. P.M. On the 19th a transit ingress of the first satellite at 0h. 52m. A.M., and of its shadow at 1h. 32m. A.M.; a transit egress of the satellite at 3h. 8m. A.M., and of the shadow at 3h. 48m. A.M.; an occultation disappearance of the first satellite at 10h. 1m. P.M. On the 19th an eclipse reappearance of the first satellite at 0h. 56m. 44s. A.M.; a transit egress of the shadow of the second satellite at 5h. 48m. P.M.; a transit ingress of the first satellite at 7h. 19m. P.M., of its shadow at 8h. 1m. P.M.; a transit egress of the satellite at 8h. 1m. P.M., and of its shadow at 9h. 35m. P.M. On the 21st an eclipse reappearance of the first satellite at 7h. 25m. 36s. P.M.; an occultation disappearance of the third satellite at 0h. 54m. A.M., its eclipse disappearance at 1h. 2m. 49s. A.M., and its eclipse reappearance at 3h. 49m. 21s. A.M. On the 24th a transit ingress of the second satellite at 2h. 58m. A.M., and of its shadow at 4h. 28m. A.M. On the 25th a transit egress of the shadow of the third satellite at 6h. 5m. P.M.; an occultation disappearance of the second satellite at 9h. 49m. P.M.; a transit ingress of the shadow of the fourth satellite at 10h. 39m. P.M., and its egress at 11h. 48m. P.M. On the 26th an eclipse reappearance of the second satellite at 1h. 59m. 19s. A.M.; a transit ingress of the first satellite at 2h. 38m. A.M., and of its shadow at 3h. 27m. A.M.; an occultation disappearance of the first satellite at 11h. 48m. P.M. On the 27th an eclipse reappearance of the first satellite at 2h. 52m. 6s. A.M.; a transit ingress of the shadow of the second satellite at 5h. 47m. P.M., a transit egress of the satellite itself at 6h. 45m. P.M., and of its shadow at 8h. 26m. P.M.; a transit ingress of the first satellite at 9h. 5m. P.M., and of its shadow at 9h. 55m. P.M.; a transit egress of the satellite itself at 11h. 21m. P.M. On the 28th a transit egress of the shadow of the first satellite at 0h. 12m. A.M.; an occultation disappearance of the first satellite at 6h. 15m. P.M., and its eclipse reappearance at 9h. 21m. P.M. On the 29th an occultation disappearance of the third satellite at 1h. 32m. A.M.; a transit egress of the first satellite at 5h. 48m. P.M., and of its shadow at 6h. 41m. P.M.

As Saturn does not rise till after midnight at the end of the month, we defer an ephemeris of him till February; and Uranus is also, for the purposes of the amateur, invisible.

Neptune is an evening star, and is well situated for observation. He rises on the 1st at 2h. 5m. P.M., with a northern declination of 20° 57′, and an apparent diameter of 2·7″. On the 31st he rises at three minutes after noon, with a northern declination of 20° 54′. A map of the small stars near his path will be found in the *English Mechanic* for September 7th, 1894. He describes a short retrograde path in Taurus to the S.W. of ε Tauri.

December is a fairly favourable month for the observation of shooting stars, the most important shower being the Quadrantids, the radiant point being in R.A. 15h. 12m. and 53° north declination, the greatest display being visible during the morning hours of January 1st to 3rd.

The Moon enters her first quarter at 7h. 52m. A.M. on the 4th; is full at 6h. 50m. A.M. on the 11th; enters her last quarter at 10h. 55m. P.M. on the 17th; and is new at 9h. 26m. P.M. on the 26th. She is in perigee at midnight on the 11th, and in apogee at 6h. P.M. on the 26th. At 7h. 50m. P.M. on the 1st the 5½ magnitude star h^1 (83) Aquarii will disappear at an angle of 117°, and reappear at 8h. 23m. P.M. at an angle of 176°. At 8h. 49m. P.M. on the 6th the 6th magnitude star 47 Arietis will disappear at an angle of 66°, and reappear at 10h. 4m. P.M. at an angle of 248°. On the evening of the 7th the Moon will pass through the Pleiades. At 3h. 55m. P.M. the 4th magnitude star 17 Tauri (Electra) will make a

near approach at an angle of 337°. At 4h. 0m. P.M. the 4½ magnitude star 23 Tauri (Merope) will disappear at an angle of 41°, and reappear at 4h. 55m. P.M. at an angle of 271°. At 4h. 37m. P.M. the 3rd magnitude star η Tauri (Alcyone) will disappear at an angle of 31°, and reappear at 5h. 29m. P.M. at an angle of 280°. At 5h. 10m. P.M. the 3¾ magnitude star 27 Tauri (Atlas) will disappear at an angle of 76°, and reappear at 6h. 15m. P.M. at an angle of 236°. At 5h. 14m. P.M. the 5½ magnitude star 27 Tauri (Pleione) will disappear at an angle of 60°, and reappear at 6h. 20m. P.M. at an angle of 252°. At 3h. 37m. P.M. on the 9th the 4½ magnitude star 136 Tauri will disappear (in sunlight) at an angle of 110°, and reappear at 4h. 22m. P.M. at an angle of 234°. At 7h. 21m. P.M. on the 10th the 5½ magnitude star 47 Geminorum will disappear at an angle of 66°, and reappear at 8h. 16m. P.M. at an angle of 300°. At 7h. 25m. A.M. on the 12th the 4¾ magnitude star γ Cancri will make a near approach at an angle of 23°. At 4h. 8m. A.M. on the 13th the 6th magnitude star 8 Leonis will disappear at an angle of 124°, and reappear at 5h. 11m. A.M. at an angle of 298°. At 5h. 6m. A.M. on the 15th the 5th magnitude star τ Leonis (a pretty, though wide, double star; 5, 8 magnitudes, 169°, 95°) will disappear at an angle of 143°, and reappear at 6h. 11m. A.M. at an angle of 291°. At 5h. 48m. A.M. on the 17th the 5¼ magnitude star 49 Virginis will make a near approach at an angle of 217°, and at 6h. 12m. A.M. the 6½ magnitude star 50 Virginis will make a near approach at an angle of 135°.

Chess Column.

By C. D. Locock, B.A.Oxon.

COMMUNICATIONS for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

Solutions of December Problems (A. C. Challenger).

No. 1.

Q to R3 and mates next move.

CORRECT SOLUTIONS received from A. E. Whitehouse, J. T. Blakemore, A. Louis, G. G. Beazley, White Knight, W. Willby, N. Alliston, E. W. Brook, J. St. L. Kirwan, F. H. Bolton.

No. 2.

Author's Solution.—1. Q. to Kt3, &c.

(There is, unfortunately, another solution discovered by most of our solvers, beginning with 1. Kt to K2.)

CORRECT SOLUTIONS received from H. S. Brandreth, A. Louis, W. Willby, White Knight, N. Alliston, A. E. Whitehouse (author's solution), J. T. Blakemore (both solutions), E. W. Brook, J. St. L. Kirwan.

Alpha should have been credited with correct solutions of both the November problems.

N. Alliston.—Key-moves alone are quite sufficient.

E. H. R.—Communication received just a day too late for insertion last month.

W. Willby.—Your two-mover is a great improvement on the last, but it is rather lacking in variety, and there are duals after 1. . . P becomes B or Kt, besides the one you mention. Could you not contrive to eradicate these and obtain additional variety at the same time?

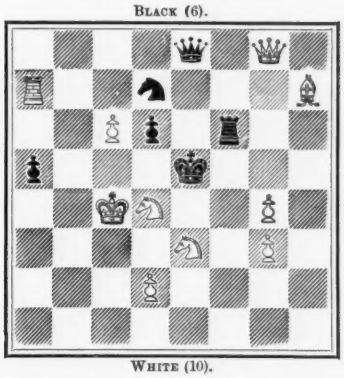
A. G. Fellowes.—You will discover the sui-mate below. The four-mover we shall be glad to publish next month without the dedication, if you have no objection. There are so many dedicated problems nowadays that one feels inclined, perhaps unreasonably, to discourage the custom.

J. St. L. Kirwan.—Thanks for the problem, which shall be examined.

PROBLEMS.

By A. G. FELLOWES.

BLACK (6).



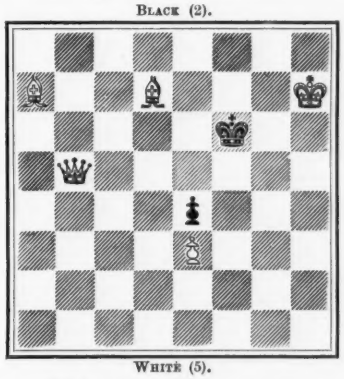
WHITE (10).

White compels Black to mate in six moves.

Mr. Fellowes informs us that the above problem was composed expressly for KNOWLEDGE with the board and men which he won as first prize in our recent Problem Tourney. Those of our solvers who succeed in fathoming the ingenious idea will agree with us that the result is fully worthy of the means employed, and an excellent testimonial to the value of the same. To encourage the timid we may state that White's moves are all checks, and Black's replies all forced. Those who like something simpler will find it below, adorned with perhaps one "surprise" mate.

By C. D. LOCOCK.

BLACK (2).



WHITE (5).

White mates in two moves.

The following game was played in the Surrey *v.* Sussex match at Brighton on December 8th. The score is from the *Daily News*.

"French Defence."

WHITE. H. W. Butler (Sussex).	BLACK. A. Howell (Surrey).
1. P to K4	1. P to K3
2. B to Kt5 (*a*)	2. P to QR3 (*b*)
3. B to R4	3. Kt to K2 (*c*)
4. P to QB3	4. Kt to Kt3
5. P to Q4	5. B to K2
6. Kt to KB3 (*d*)	6. Castles
7. B to K3	7. P to Q3
8. Castles	8. P to K4
9. B to B2	9. P to KB4 (*e*)
10. P × BP	10. B × P

11. B × B	11. R × B
12. Q to Kt3ch	12. K to R1 (*f*)
13. Q × P	13. Kt to Q2
14. Q to B6 (*g*)	14. Kt to Kt3 (*h*)
15. QKt to Q2	15. Kt to KB5
16. P × P	16. P × P
17. QR to Q1	17. Q to KB1 (*i*)
18. B × KKt	18. P × B
19. KR to K1 (*j*)	19. P to KKt4 !
20. Kt to Kt3 ?	20. P to Kt5
21. KKt to Q4	21. R to B3 ?
22. Kt to K6 (*k*)	22. Q to R3
23. Kt (Kt3) to Q4	23. P to Kt6
24. P to R3 (*l*)	24. P × Pch
25. K × P	25. R to KKt1
26. Q to K4 (*m*)	26. KR to Kt3
27. R to KKt1	27. B to R5ch
28. K to B1	28. R to K1 (*n*)
29. Q to K5ch	29. R to B3 (*o*)

Drawn Game (*p*)

NOTES.

(*a*) Mr. Butler's own peculiar attack, which he adopts equally against 1. . . P to K4.

(*b*) Very feeble. The Bishop evidently wants to go eventually to QB2 (*vide* White's ninth move). We would suggest instead either 2. . . P to QB3, 3. B to R4, P to Q4 ; or 2 . . . Q to Kt4, 3. B to Bsq, Q to Qsq ; which reduces the opening to an absurdity.

(*c*) Now he might as well follow up his last move by 3. . . P to QKt4 and 4. . . P to Q4. So White evidently thought, judging from his next move.

(*d*) P to KB4 first seems preferable.

(*e*) This appears to be an oversight, though it does not turn out badly.

(*f*) In view of the move pointed out in note (*g*), perhaps 12. . . R to B2 is better. Some interesting play might then result from 13. Kt to Kt5, B × Kt ; 14. B × B, Q × B ; 15. Q × P, Kt to R5 ; 16. P to KB4 ! (If 16. Q × R, P to B3).

(*g*) 14. Q to K4 is perhaps better. If then 14. . . R to B2, 15. Kt to Kt5, R to B3 ; 16. P to KR4, etc.

(*h*) In order to free the Queen ; but the Knight becomes rather out of play, and should go to KBsq instead.

(*i*) He can hardly defend the QBP without submitting to an exchange of Queens.

(*j*) There seems to be no objection to Kt to Q4 at once. White seems hardly to realize the danger of the coming attack.

(*k*) Now he might safely play 22. Q × P, Kt to Q4 ; 23. Q to K5. The move made increases the dangers of his position.

(*l*) Here surely 24. BP × P, P × P ; 25. P to KR3 is much better.

(*m*) Or simply K to Bsq, with a view to R to K2 when necessary. On his next move he is probably right to reject 27. Kt × P as being too risky. Not improbably both players may have been pressed for time at this stage.

(*n*) 28. . . P to B4 is clearly useless on account of the check.

(*o*) Moving the King would lose the Queen by 30. Kt to KB5, etc.

(*p*) Probably the players agreed to draw prematurely rather than have the spoil divided by the adjudicator in London. White's best move is apparently 30. P to QKt3, to keep out the Knight. If then 30. . . . P to QB4, 31. Q×P (If 31. Kt to KB5, Q to R4 (best), and wins), 31. . . . KR×Kt, 32. Kt×R, Q×Kt ; 33. Q to Q4ch, K to Ktsq ; 34. Q to Q2, Kt to B5 (!) and wins. Again, if 30. P to KKt4, P×P *en passant* ch ; 31. K to Kt2, Kt to B5 (best). [Not now 31. . . . P to B4, 32. Kt to B5 (!), Q to R4 ; 33. KR to Bsq, with some chances.] On the whole we think that Black should win.

CHESS INTELLIGENCE.

The New York tournament concluded in November with the following scores :—Steinitz, 8½ ; Albin, 6½ ; Hymes and Showalter, 6 ; Delmar and Pillsbury, 5 ; Halpern, Hanham and Rocamora, 4 ; Baird and Jasnagrodsky, 3. The last-mentioned player would probably have been higher if he could have played with less rapidity. Mr. Pillsbury seems also to have been out of form.

Paris have recently defeated St. Petersburg in a correspondence game (QP opening). The other, an Evans Gambit, will probably be drawn.

It is stated that the Liverpool Club have drawn their second game with Mr. Steinitz, who won the first game, and accordingly wins the match.

Surrey played Sussex in the Southern Counties Association competition on December 8th. Only a little over two and a half hours' play was possible, the result being that no less than eight games were drawn, and four others left for adjudication. Of the decided games, Surrey won three and Sussex one. We are strongly of the opinion that important county matches should not be played unless at least three hours' play can be guaranteed. A match reported in this magazine a few months ago (Metropolitan *v.* City) resulted in an even greater *fiasco*.

Colonel Ryan, of Brighton, offers numerous prizes for a chess and draughts problem tourney. The chess problems must be "letter" problems in three moves. Further particulars may be obtained from the Chess Editor, *Leeds Mercury*, Leeds.

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